MAY 1925 35 CENTS

RADIO BROADCAST

How to Build a Two-Stage Radio-Frequency Amplifier

THE MARCH OF RADIO

A New Method of Transmitting Pictures by Wire or Radio

DOUBLEDAY, PAGE & COMPANY GARDEN CITY, NEW YORK

RADIO BROADCAST

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Vol. 7, No. 1 May, 1925

A New Method of Transmitting Pictures by Wire or Radio

A Review of Existing Methods of Sending Photographs—Details of the Cooley System Never Before Published—An Efficient and Very Fast Transmitter Whose Applications are Many and Important

By CHARLES C. HENRY

IMAGINE, a hundred messengers delivering photographic reproductions of business letters, photographs, printed matter, legal papers, social correspondence, and innumerable forms of communication received from distant points by a single instrument. The instrument that will accomplish this is already known to many as a phototelegraphic receiver. Few even of those who have followed the recent developments in phototelegraphy appreciate the huge commercial and economic importance it will have in the near future.

Most of us read with interest the accounts of the transmitting of photographs across the Atlantic and admired the engineering achievement of reproducing them with such fidelity here in America. In hundreds of magazines and papers, copies of the received pictures of President Coolidge, Secretary Hughes, the Prince of Wales, and others were prominently displayed.

The whole world has heard about the transmission of the 1924 Republican Presidential Convention pictures by the American Telephone and Telegraph Company. The quality of the pictures received in New York from Cleveland compare favorably with the average newspaper picture.

The Chicago *Tribune*, the New York *Daily News*, and the Los Angeles *Times* have been tied together for several months with the Marvin Ferree system of phototelegraphy operating over leased telegraph lines. Pictures are exchanged daily between these prominent newspapers and appear in their columns beside other news pictures. There is no noticeable difference in quality between the two. The trade name "Telepix" is attached to all of these telegraphed photos.

Not long ago, C. Francis Jenkins, of Washington, D. C., conducted radio phototransmission experiments between Anacostia, Maryland, and Medford Hillside, Massachusetts. His received pictures were badly mutilated by commercial radio telegraph traffic because of the particular wavelength used; but with better radio facilities at his command, it is likely that his test pictures would have been quite successful.

Edouard Bélin is at present in New York engaged in the intensely interesting experiment

of attempting to receive radio photograms from a Paris station. The St. Louis *Post-Dispatch* and the New York *World* have closely followed and supported his work for many years. Using his system, these two newspapers transmitted pictures with great success last December between St. Louis and New York City.

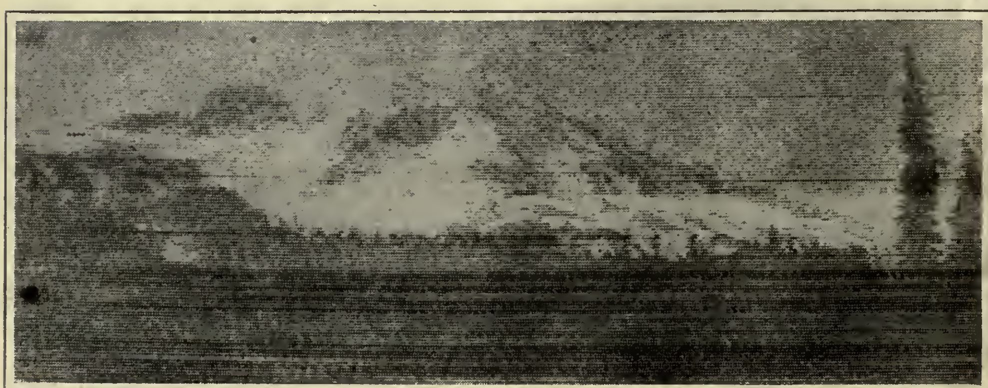
Those engaged in this work of phototelegraphy are racing with each other in their attempts to build up the first strong commercial foundation. It seems evident that the commercial field will be limited to one or two systems. It is quite possible that the ultimate system will be made up of contributions by the many scientists now engaged in the work.

Thirty-Seven Seconds for a Picture

The Cooley system, described in Mr. Henry's article, is capable of transmitting a five-by-seven-inch half-tone photograph or a line drawing over a perfect wire line in thirty-seven seconds. There are other methods in present use which send photographs by radio and by wire, but the time consumed is from four to fifteen minutes. Speeding up the transmission involves very great technical problems. Notable among these are the systems of the Radio Corporation, the American Telephone and Telegraph Company, Marvin Ferree, Edouard Bélin, and C. Francis Jenkins. Radio Broadcast is proud to present this story of Mr. Cooley's achievements, particularly because much of the development work was done in its own Laboratory.

Every sign points toward the early perfection of a commercially practicable system of phototelegraphy whose aid and influence in industry will be incalculable. Radio Broadcast believes the technical attainments of Mr. Cooley's system are of the greatest importance. Every reader who is interested in general scientific progress and all those engaged in developing radio and wire communication will read of what has been done with the deepest interest.—The Editor

Millions of dollars have been spent for the development of phototelegraphy by those who appreciate its adaptability to handling communications of all kinds, whether it be photographs, drawings, script, or printed matter. The speed at which typewritten messages may be transmitted over such a system is so great that one set of apparatus could handle all the messages going between New York and Boston, which are now being transmitted over thirteen lines of automatic printing telegraph. The adaptation of phototelegraphy to transoceanic radio communication will not only speed up the service but will tend greatly to reduce the unfortunate effect that static now has. In the present system, letters forming the words are coded into dots and dashes and sent very rapidly. A bad crash of static will completely destroy one or more words. Such a crash of static would only mar portions of letters from different words if the message were transmitted by phototelegraphy. To meet the keen competition of the cables, transoceanic radio companies must adapt some system that will insure reliability and at the same



MOUNT RAINIER, IN WASHINGTON

Transmitted by the Cooley system. Much of the recent development work on this system which was started in Cambridge, Massachusetts, in 1922, was done in the Laboratory of Radio Broadcast at Garden City

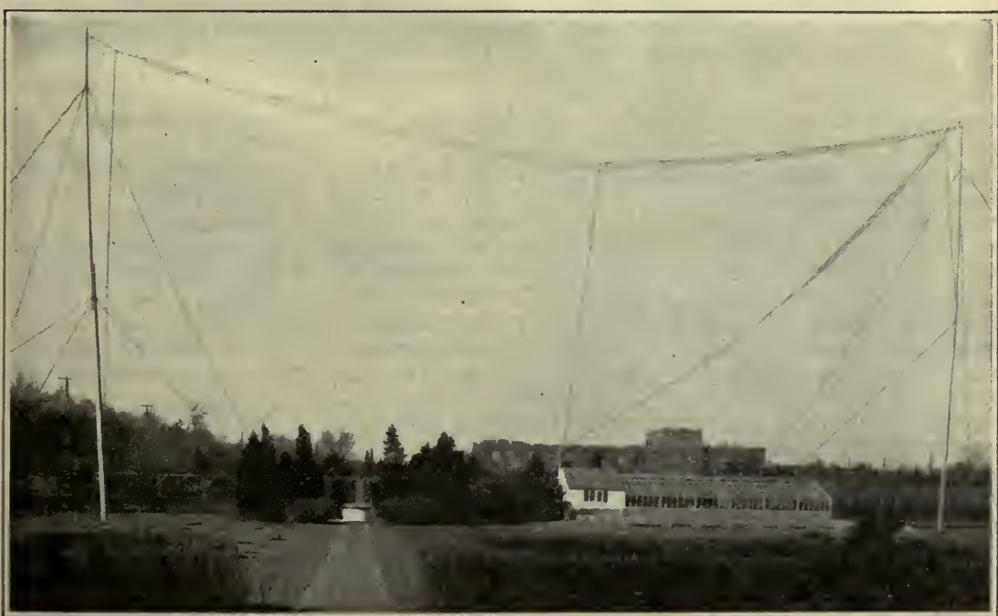
time increase the capacities of their present stations.

HOW PICTURES SOUND

IF YOU should ever listen to radio signals that are serving to transmit photographs, you will hear a buzz of constant pitch but of varying intensity. The variations in intensity seem to repeat every second, or probably oftener, but each repetition will be slightly different from the previous buzz. Each impulse, that goes to make up the buzz, represents the light coming from a tiny area on the picture being transmitted. Every one knows that newspaper prints are made up of thousands of tiny dots. In light places on the pictures, these dots are very small. The dark portions are made up of dots so large they form together to make a solid black mass. When transmitting any photograph, a dot is sent with each electrical impulse, but these impulses occur so rapidly that they appear as a buzz when one hears them on the radio. Rows of dots are sent in rapid succession; this explains the repetition of the signal intensities at short intervals. It is not necessary to split the photograph up into tiny dots before transmitting, for this is automatically done by the electrical apparatus in the photograph transmitter.

At the receiving station, the electrical impulses are transferred on a suitable paper back into dots and these dots are arranged exactly as they are on the original picture. To do this, both transmitting and receiving apparatus must operate at exactly the same speed, that is to say, they must be synchronized. The technical problems involved in synchronizing have been some of the most important of the many difficult ones in developing the transmitting apparatus.

A picture that is to be transmitted across the Atlantic by the Radio Corporation of America's system, or from one city to another over the Bell System lines, is first printed on a transparent film. This process is rather simple and does not require much time. Nevertheless, such a procedure would involve undesirable complications for constant and regular commercial service. Both the Telepix and Bélin systems call for especial types of negatives peculiar to the transmitting methods employed. The making of such negatives requires a little more time than do the prints used on the Radio Corporation and American Telephone and Telegraph Company



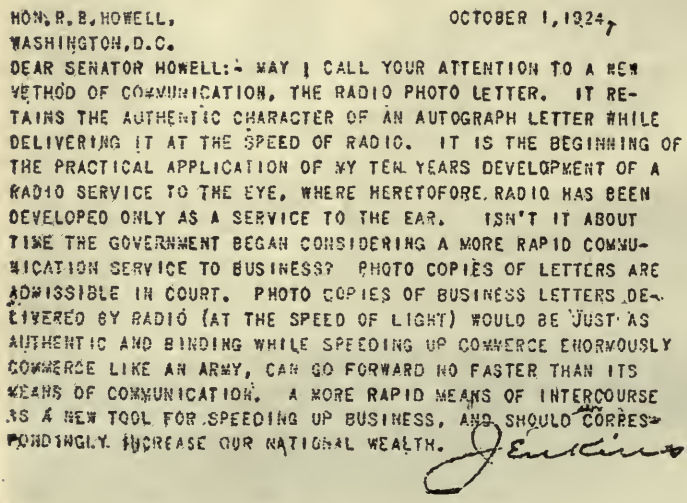
Radio Broadcast Photograph

THE RADIO BROADCAST LABORATORY

Showing the antenna and counterpoise system. Two masts eighty-five feet high support the two cage antennas. The longer antenna has a spread of 154 feet. The laboratory where Mr. Cooley did much of the development work on his photograph transmission system is located in the white cabin between the two masts. The buildings of Doubleday, Page & Company are in the background

BEFORE—AND AFTER

The original and a radio transmitted version of a photograph sent during the early experiments of the Cooley-Hainsworth system. The picture on the right was sent with fifty dots to the inch. Average newspaper halftones have sixty-five dots to the inch (this magazine's halftones have 110 dots to the inch)



HON. R. B. HOWELL, OCTOBER 1, 1924,
WASHINGTON, D.C.
DEAR SENATOR HOWELL:- MAY I CALL YOUR ATTENTION TO A NEW METHOD OF COMMUNICATION, THE RADIO PHOTO LETTER. IT RETAINS THE AUTHENTIC CHARACTER OF AN AUTOGRAPH LETTER WHILE DELIVERING IT AT THE SPEED OF RADIO. IT IS THE BEGINNING OF THE PRACTICAL APPLICATION OF MY TEN YEARS DEVELOPMENT OF A RADIO SERVICE TO THE EYE, WHERE HERETOFORE RADIO HAS BEEN DEVELOPED ONLY AS A SERVICE TO THE EAR. ISN'T IT ABOUT TIME THE GOVERNMENT BEGAN CONSIDERING A MORE RAPID COMMUNICATION SERVICE TO BUSINESS? PHOTO COPIES OF LETTERS ARE ADMISSIBLE IN COURT. PHOTO COPIES OF BUSINESS LETTERS DELIVERED BY RADIO (AT THE SPEED OF LIGHT) WOULD BE JUST AS AUTHENTIC AND BINDING WHILE SPEEDING UP COMMERCE ENORMOUSLY COMMERCE LIKE AN ARMY, CAN GO FORWARD NO FASTER THAN ITS MEANS OF COMMUNICATION. A MORE RAPID MEANS OF INTERCOURSE IS A NEW TOOL FOR SPEEDING UP BUSINESS, AND SHOULD CORRESPONDINGLY INCREASE OUR NATIONAL WEALTH. J. Jenkins

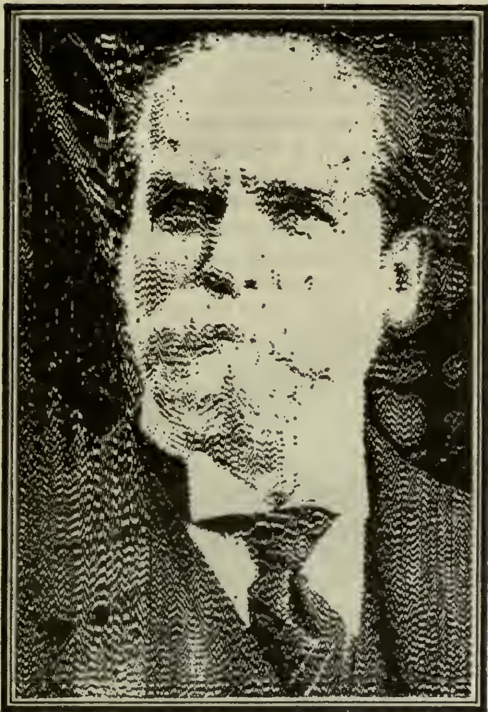
A REAL RADIO LETTER

Sent by the inventor of the system, C. Francis Jenkins, from Anacostia, Maryland, to Washington by radio last October. The Jenkins system has some points in common with the development of Mr. Cooley, but in essence, the Cooley system operates along other and entirely new lines. The radio photoletter may in a few years be an accepted part of our industrial system

systems. A good commercial system of phototelegraphy should be able to transmit, without further preparation, any photograph or message printed on ordinary photograph paper.

THE MECHANICS OF PHOTOGRAPH SENDING

SOME systems transmit the signals in dots and dashes instead of dots of intensity corresponding to the portion of the picture being transmitted. The dashes represent dark places in the pictures and the dots make up the light areas. This system is readily adapted to operation on telegraph circuits or radio telegraph stations. The cost of these



CHARLES EVANS HUGHES

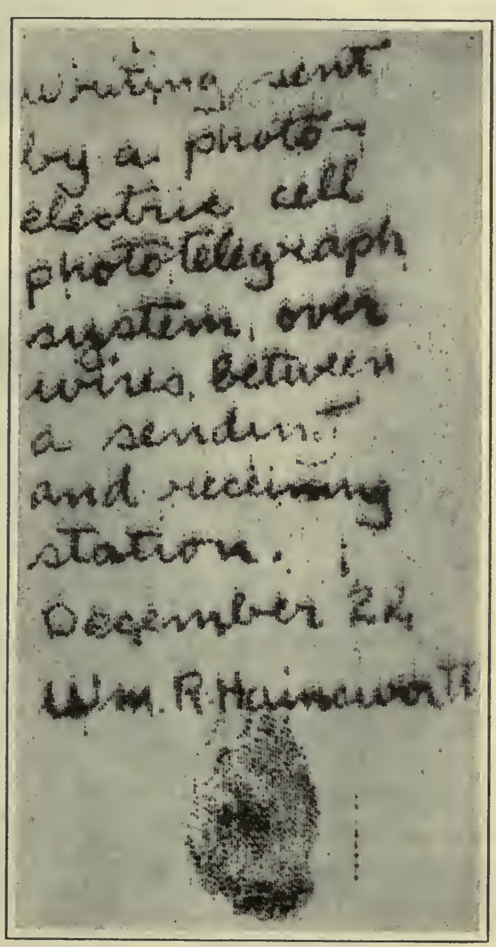
Former Secretary of State, whose photograph was sent across the Atlantic by the Ranger-Radio Corporation of America "photoradiogram" system. The Ranger method, while used in this instance on a high power, long wavelength radio circuit, can be used on a wire line equally well

communication channels is much lower than the ones required for the dot system as used by the American Telephone and Telegraph Company, Jenkins, Bélin, and others. The Radio Corporation sent pictures across the Atlantic in twenty minutes by the dot-dash method. An hour or more is required to transmit a Telepix picture over a telegraph wire, but these pictures are larger and contain more detail than those handled by the Radio Corporation. The American Telephone and Telegraph Company have transmitted pictures of considerable detail in four or five minutes, but special wires were required. The cost of the communication channels used is an important factor that will determine the commercial value of any system. In some cases the high cost may be offset by the great capacity of the apparatus operating over the channel.

When a system of phototelegraphy goes into commercial use, there will probably be separate rates for printed matter and photographs. This is because the adjustments of the apparatus can remain fixed when handling black and white subjects while the transmitting of a photograph would require special attention so that the tones and shades may be properly reproduced at the receiving station. A picture having little contrast and printed on sepia paper would require adjustments of the apparatus entirely different from one having contrast and printed on a glossy paper.

THE STORY OF THE COOLEY SYSTEM

THE Cooley system, which has never been made public, incorporates more contributions to the art than does that of any other inventor. This development is an outgrowth of



VERITABLE "RADIO WRITING"

A sample of writing of Doctor Hainsworth, one of the inventors of the Cooley-Hainsworth phototelegraph transmitting system. This was sent experimentally in Cambridge in 1922

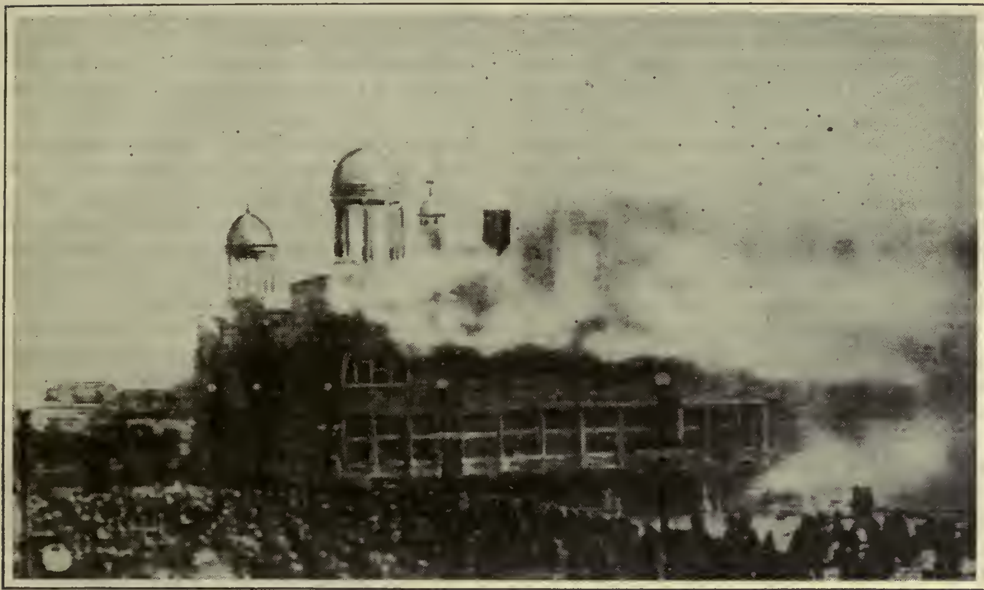
work begun by Dr. William R. Hainsworth at the Massachusetts Institute of Technology, Cambridge, Massachusetts, in November, 1921. From that time until March, 1923, the investigation centered on the use of methods paralleling very closely those made public by the American Telephone and Telegraph Company last summer. Austin G. Cooley, then a student at the Massachusetts Institute of Technology, joined Dr. Hainsworth in the fall of 1922 for the purpose of assisting in the application of radio to the equipment which was being operated satisfactorily in the laboratory.

Having become convinced that this system was too unreliable, that it was definitely limited in speed, and that it was encumbered with so many obstacles in the way of its future acceptance as anything but an elaborate laboratory toy, in the spring of 1923 they decided to abandon their ideas and to start out along entirely different lines of research.

C. E. Tucker, a well known authority on electrical communication; Prof. F. S. Dellenbaugh, a prominent electrical engineer; Dr. F. G. Keys, director of the Physical Chemistry Department at the Institute; Captain Clayton and Sergeant Truax, both of the United States Army Signal Corps, were a few of the members of the faculty of the Massachusetts Institute of Technology who took an active interest in the Cooley-Hainsworth development work and furnished valuable assistance in securing

RECEIVING APPARATUS OF THE RANGER SYSTEM

Used by the Radio Corporation of America. The picture is printed on the small revolving drum in the foreground which is driven by the motor directly behind it. Exact synchronism between the motor of the transmitting and receiving apparatus is an essential of all photographic sending systems. The first public demonstration of this system took place during the week of December 1, 1924, between New York and London



A TELEPIX PHOTOGRAPH

Which was sent between New York and Chicago. The photograph was retouched after it was received. A comparison between this and the original below shows that considerable detail was lost in the transmitting process. A picture of this type is one of the most difficult to transmit

the necessary apparatus and instruments. Dr. Jacob Kunz of the University of Illinois had contributed materially to the work by placing at their disposal his newly developed photoelectric cell.

Many of the radio fans in the vicinity of

AN ORIGINAL PHOTOGRAPH

The telegraph version is shown above

Boston will recall hearing mysterious buzzes accompanied by clicks occurring at intervals of a little more than a second apart on a 200 meter radio wave during the month of December, 1922. Many inquiries were answered by explaining that "special tests on radio control were being conducted." Probably no one had the slightest conception that pictures were being sent over the air. It was from the experimental radio station 1XM, located at the Institute, that the pictures were transmitted. They were received in Dr. Hainsworth's laboratory, not far distant. The quality of the received pictures was poor, but the work must be given considerable credit, for it was probably the first time that the synchronizing of the receiver with the transmitter was accomplished by radio.

The development work on the phototelegraphic system was conducted in Dr. Hainsworth's laboratory and radio station 1XM where Mr. Cooley spent most of his time. In the summer of 1923, the first tests on the new system designed by Mr. Cooley were made in this radio "shack." It is seldom that apparatus of new and unusual design meets its builder's expectations. Mr. Cooley was prepared to be disappointed. But on the contrary, unusual and encouraging results were obtained.

With the aid of a colleague, Mr. R. A. Cunningham, Mr. Cooley rushed along the construction work on a complete set of apparatus to be used for demonstration purposes. Dr. Hainsworth left Boston during the summer of 1923 to take up some other work in Seattle. Since that time he has not been able to take an active part in the development of the phototelegraphy system for which he is responsible.

AT THE RADIO BROADCAST LABORATORY

WHEN Arthur H. Lynch, editor of this magazine, was asked to assist in obtaining laboratory space for the development of the Cooley phototelegraphic work, he was quick to realize its possibilities. Without the slightest hesitation he freely offered the facilities of the Radio Broadcast Laboratory for the test of Cooley's ideas. Accordingly, night and day, and with this precious equipment constantly under the eyes of watchmen, Cooley pursued his tests of a high speed phototransmission device for reproducing at distant points photographs having all the shades necessary to make up a perfect picture.

It was not until after the International Radio Broadcast Tests in December, 1924, that the various units of the new Cooley phototelegraphic system had been properly coördinated and it was possible to send pictures of satisfactory quality in the Radio Broadcast Laboratory. Arrangements were made to loop the picture signals through two local telephone exchanges and to return them to the Laboratory, where both transmission and reception might be watched by the operators. The transmitter was connected to a telegraph line which terminated at the Radio Broadcast office. At this point, the signals were acoustically transferred to a telephone which was connected to the private branch exchange of Doubleday, Page & Company. This private branch exchange was in turn connected to the Garden City telephone exchange, where the usual telephone connections were set up for the wire which serves the Laboratory telephone.

SUCCESS ON THE FIRST TEST

IN THIRTY minutes ten pictures were transmitted. The apparatus was readily synchronized within ten seconds before the reception of each picture began. The pictures transmitted were taken from magazines and rotogravure sections of newspapers. In the receiving apparatus, the pictures were printed out on an inexpensive photographic paper that required developing and fixing before the image could be seen. The thirty minutes mentioned included the time required for this work. The quality of the received pictures was fair, in spite of a defective device in the transmitter. This device was the photoelectric cell, a necessary part of the equipment. Air had leaked into it and caused its action to be sluggish. A new one is now being built by Dr. Kunz, especially designed to meet the high speed requirements in this system of phototelegraphy.

The limitations of the Cooley system are unknown. It is probable that a commercial type model, which can handle four hundred messages an hour, will be constructed within the next year. Compare this with the present machine-printing telegraph, which averages about fifty messages an hour.

Using the Cooley design, the transmitter or receiver is neither bulky nor expensive to construct. In a commercial embodiment planned for an early date, a portable transmitter will be built for the use of newspaper photographers. It will be necessary only to connect the machine to the electric light socket, get the newspaper office by telephone, and place

the negative, still wet from the developing solution (if utmost speed is desired) in the machine, and, in the course of a minute or two, transmit it to the photographer's headquarters. And, wonderful though it may seem, the photographer may send it to be received as either a negative or a positive. He may also send a print or even a clipping from a magazine or newspaper and have the replica in the hands of the editor within a few minutes after completing his telephone connection. Since this work may be done acoustically, there is no need of any electrical connection between the photo-transmitter and the telephone.

ONE PICTURE—EVERY HALF MINUTE

MR. COOLEY has not lost sight of the fact that 1200 impulses per second is about the maximum number that can be transmitted over a commercial telephone line. This limits the speed of transmission to about seventeen square inches per minute if the picture is to be printed out with sixty-five dots per inch, this being standard for newspaper prints. The speed might be increased through the use of high quality transmission lines such as are used for carrying programs from a studio to a broadcast station. In such lines the circuits are so arranged that frequencies up to 4000 cycles per second are passed. At the 4000 impulse rate, only thirty-seven seconds would be required to send a five-by-seven-inch picture.

Before this copy of RADIO BROADCAST reaches the reader, it is confidentially expected that the necessary alterations in the present model will be made, so that the most detailed photograph with all its half-tone shadings can be transmitted over any telephone or radio circuit that is capable of transmitting intelligible speech. There is every hope for the early detailed announcement of this phototelegraphic system that is fundamentally new and novel in its transmission and receiving methods.

The quality of the photographs transmitted by this system can be made especially good for magazine use. By increasing the speed of transmission, photographs can be sent at a greater speed, for use in newspapers. In its final form, the apparatus will be extremely simple, relatively inexpensive, and equally adaptable for line or radio transmission.

In connection with this work, a very important new use of the vacuum tube has been discovered and a very plausible theory has

THE ORIGINAL—AND THE TELEGRAPHED PHOTOGRAPH

Sent from New York to Chicago by the "Telepix" system now in use by the Chicago *Tribune* and the New York *Daily News*. The cut on the right is a print of the wired picture after it had been slightly retouched. At present, wired photography is decidedly expensive and too slow for general commercial use

been formulated for its operation. Still another use of the vacuum tube has been developed to an extent which shows excellent promise. It is now thought that it can be included in the design of a new and novel receiving circuit which will be a great improvement in the sensitivity as compared to present-day receivers. Many patents are now pending for the various inventions which have been made in connection with the Cooley system. As rapidly as the patent work permits, RADIO BROADCAST will disclose the technical developments that are made as the work progresses.

There has been much discussion in recent years about the theories of the German scientist Einstein and his theory of the relativity of time and space. In a very definite and striking way, the radio transmission of photographs illustrates the contentions of that famous scientist, although certainly not in the way he intended.

This new art has reached the stage where commercial telephone, telegraph, and radio companies must recognize it as an ally or prepare to meet its competition. The constant barrier of distance is again about to be dealt a blow as deadly as that delivered by the general utilization of the locomotive, automobile, airplane, the telegraph, and radio. Since time is the only important measure of geographical space, phototelegraphy bids fair appreciably to shrink the magnitude of our world.

CALVIN COOLIDGE

President of the United States. This photograph was also sent across the Atlantic by the Ranger system. The dots and lines which go to make the picture can be clearly seen.

COMPLETE instructions on how to build the Roberts four-tube Knockout receiver so that it can be fitted into any phonograph cabinet will appear in an early number of RADIO BROADCAST. *It is now possible to buy manufactured sets which can be used in a phonograph cabinet, but thus far, no information has yet appeared which is of any help to the home builder. The mechanical details of the receiver are especially well worked out and the panel can be used with any type of cabinet phonograph now on the market.*

How the Government Is Regulating Radio Broadcasting

The "Interest of the Listener" Is the Final Test of Regulation —The Present Situation and Future Possibilities—An Interview with Judge Davis of the Department of Commerce

BY R. S. McBRIDE

"INCREASING service to the listener," is the only proper basis for radio regulation and development in the opinion of Herbert Hoover, Secretary of Commerce. But it is a long way from this generalization to the practical working out of a Government policy. So RADIO BROADCAST has undertaken to study the departmental policy as to the control of broadcasting to see just what this statement really means. For this purpose, an interview was secured with Judge Stephen B. Davis, Solicitor of the Department of Commerce, with results that are most gratifying from the point of view of the listener. There is no doubt that the radio audience is assured of every protection and aid which the skilled agents of the Government can offer and that fair and helpful service will be given to any broadcasting development that has real merit.

The Wavelength's the Thing

Everyone who knows the pleasant pressure of head phones or who is often attentive to a loud speaker has discovered that the ether paths are becoming more crowded every day. The average radio listener—if there is such a person—has probably wondered how the Government is dealing with the serious problem of distributing the broadcast wavelengths, which, when one considers the number of applicants for the comparatively few available, are few enough. There has been a deal of excited speculation on what would happen if a number of so-called super-power stations were licensed—speculation, it may be said, with only an indifferent knowledge of the facts. Mr. McBride has gone to headquarters for his information and we think he has presented very well the attitude of the Department of Commerce. The Department is charged with administering the Radio Act under the very difficult changing conditions of radio. That radio progress has not been greatly hindered by hasty and ill-considered legislation is due to the many good and capable friends of radio who have used their influence honestly and well in Washington.—THE EDITOR

GARDENING FOR JACK OF THE BEAN STALK

ONE can well imagine the troubles which a gardener would have had caring for the yard of Jack of bean-stalk fame. But such a gardener would have had no more trouble in pruning the bean stalk to shapely form than does the Department of Commerce in directing the growth of the radio broadcasting business. In this, as in the fairy tale, not even the sky is the limit, so it seems.

Four years ago—or August, 1921, to be exact—the first broadcasting was begun. To-day the Department lists nearly 600 broadcasting stations in operation or under construction. These must be guided and safeguarded if the real interest of the industry, which means the wishes of the general public of listeners, is to be adequately protected. And with ether space so much at a premium to-day, the task is not an easy one.

In view of the continued rapid growth of broadcasting, many have foreseen a constantly increasing confusion in the air, which would be helpful to no one and harmful to all. Anticipating this situation the Department was asked, "How much worse must things get before they can begin to improve again?" Or putting it another way, "How much more broadcasting interference must the public tolerate before it will rise up and demand rigid regulation and complete elimination of the interfering stations?"

These questions were addressed to Judge Davis, who is really acting as first officer of

the good ship *Radio*. The answer which he makes is most encouraging. He says, "Conditions will not be allowed to get any worse. They are far too bad already." Pressed further on this matter, Judge Davis stated that there are no more wavelengths available for broadcasting in the Class B wavelength area. Practically, this is an announcement to all newcomers in the broadcasting field that they will not be permitted to crowd in and add confusion between 280 and 550 meters. And to the broadcast listeners, as to all other well wishers of radio, this is the most welcome news of many months past.

FIXED CONDITIONS TO-DAY CHANGE TO-MORROW

BUT in stating this conclusion, Judge Davis repeatedly emphasized that no plan of the Department can be regarded as permanently fixed. Radio itself is changing; the Department's plans must keep pace or become a handicap. It is clearly the purpose of the Department to prevent any such unfortunate result. For to-day, however, it is safe to conclude that the Department intends to protect the listener's interest by limiting the number of stations which can work within the so-called Class B range. To-morrow some new scheme may develop which will permit granting of more Class B licenses on these wavelengths, but radio science to-day does not apparently hold forth this possibility.

Already in this Class B range, the average broadcast listener has a choice of several programs at ordinary broadcasting hours. But the Department is not content with this, for it seems to be well demonstrated that with a gradual advance in power at the stations in different parts of the country, the number of unquestionably good programs from which the great body of radio listeners may choose can be increased up to eight or ten. If so, many different stations can be made regularly available to each of us. There will then be ample opportunity for choice between grand opera, jazz, oratory, and educational productions. The Department is working toward this goal, cautiously, to be sure, but with every confidence that it is entirely practicable.

SAFE-GUARDING SMALL STATIONS

CLASS B stations with power of from 500 to 2000 watts now afford the most reliable broadcasting service over a considerable area. But the Department still regards the small local stations of great importance to the communities that they serve. Secretary Hoover, commenting on this situation at the recent radio conference, said:

> I know the importance of these smaller stations to the communities they serve. I know that there are millions of crystal sets and small tube sets whose owners are practically compelled to-day to rely upon the stations at their doors and are getting good service from them. These are the people I have in mind and the ones I primarily want to serve, for the owner of the multi-tube set, reaching out for an indefinite number of miles, is pretty well able to look out for himself. I want to see the little fellow get something more than he has now.

From this statement it is evident that any plan for improving the service from the powerful Class B group is not going to involve serious hazards for local use of low-power stations that fit properly into the general scheme of things.

The Department, Judge Davis emphasizes, still regards the small set, even the crystal set, as the most important unit for consideration in planning broadcast regulations.

THE SUPER-POWER BUG-A-BOO

THE recent suggestion of Mr. David Sarnoff that one or two very powerful stations using perhaps 50,000 watts should be erected to serve the entire country aroused a storm of protest. Much of the objection came from misunderstanding. Some came from propaganda spread abroad by small-station broadcasters who feared the results of such a development. The Department was quick to answer these objections with the announcement that no alarming or radical changes are being contemplated.

Thus far, Judge Davis explains, only two stations have advanced as far as 2000 watts and only eight or ten are using as much as 1500 watts. This advance has been made in steps of 500 watts and each forward step is closely watched by the Department.

The object of these advances is two-fold: First, an *increase in the dependability* of radio, from the listener's point of view, over the ordinary range of regular reception. Second, an *extension of the effective range* so that the rural districts of the country will be adequately served and afforded some choice of program wherever that is possible. The first of these advantages means regular loud speaker service from stations that now are simply passable contributors to the family enjoyment when head phones are used. The second advantage means widening of the possible field of service without creation of any new stations, new interference, or new expenses.

The useful range of a broadcasting station,

the Department emphasizes, is the area within which signal strength is sufficiently greater than static or other interference that the program is regularly audible at all times during broadcasting periods. Broadcast stations with inadequate power are about as useful as an ordinary telephone beside a pneumatic riveter. We know the message desired is coming through the instrument, but it does us no good. Until we find out how to quiet the riveter of static we have no choice but to increase the power of the station so that we can hear it despite this interference.

IS BROADCAST CROWDING ONLY APPARENT?

IF WE go to the movies in the early afternoon there is usually plenty of room so that we can put our hat and overcoat in a vacant seat beside us and sit with comfort any place in the theater that we may choose. So it was in radio broadcasting a few years ago. All of the newcomers found plenty of room. They were given wavelengths that allowed all the freedom for careless operation that the crudities of early apparatus made inevitable. But to-day the broadcast territory is as badly crowded as the movies when the town's favorite star is showing in her newest film.

In the early days the Department decided that a spacing between stations of ten kilocycles was as close as could properly be used without interference. In other words, they permitted each station to take a seat ten kilocycles wide. Now all the seats are taken and each man must hold his overcoat on his lap and put his hat under his own seat. Naturally it seems a bit more crowded; but, as the Department officials clearly explained, it

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HERBERT HOOVER AND JUDGE STEPHEN B. DAVIS

Captains of the good ship *Radio*. As Secretary of Commerce, Mr. Hoover for the last four years has had to face some very difficult administrative problems, for radio communication has greatly altered during that time. Broadcasting was merely a commercial experiment in 1921. Compare the radio situation when Mr. Hoover took office, with conditions on the fourth of March, 1925, when the whole country was "hooked up" by wire and radio and enabled to hear the inaugural ceremonies in Washington. Judge Davis, as the solicitor for the Department, has been in direct touch with radio affairs and it is known that his opinions are very similar to those of Mr. Hoover's

is simply that all the assignments possible are now made, not that there is any closer assignment authorized to-day than heretofore.

The Department undertook a series of experiments during the middle of the winter to see whether a closer spacing was not feasible. In other words, they tried to make each radio seat a few inches narrower. On attempting a seven-kilocycle spacing in this experiment, came the answer very clearly. The Department admitted that the answer was very definitely "No!"

Secretary Hoover has announced this finding in unmistakable language. He says, "The recent experiment of the Department in attempting to increase the number of wavelengths by decreasing the difference to seven kilocycles proved unsuccessful with the present

development of instruments." And, further on in a recent official statement, the Secretary stated that "it is absolutely necessary to maintain a wide kilocycle separation between stations so close together (geographically). Otherwise they will destroy each other." And as the Department well recognizes, they will destroy the listener's patience and interest even more promptly.

THE SURVIVAL OF THE FITTEST

EVOLUTIONISTS explain that the advance from animal to man occurred by the survival and development of the fittest form of life. In radio, a similar evolution to the high-class station which all can anticipate for the future is now in progress. When one station makes great improvements, the neighboring stations have three choices:

DAVID SARNOFF

Vice-president and general manager of the Radio Corporation of America. At the third annual radio conference in Washington which met at the call of Secretary of Commerce Hoover in October, 1924, Mr. Sarnoff suggested that the way to solve some of the broadcasting problems would be to license several very high-powered stations of the order of fifty kilowatts which, located in various parts of the nation, would give dependable broadcast service over a large area. A high-powered broadcast station has recently been erected by the British Broadcasting Company in England

1. They may keep up by making similar improvement.
2. They may confess inferiority by continuing on the old superseded basis.
3. They may go out of business.

The history of radio indicates that alternatives 1 and 3 are about the only possible ones. Judge Davis made this point very clear by a large radio map which hangs on his office wall. On that map blue pins show the Class B stations, green pins the Class A, and black pins the stations that have been, but are no more. At almost every point where blue pins appear they are surrounded by the black markers of discontinued stations, stations which could not stand the pace and therefore quit rather than confess permanent inferiority.

The Department is wondering whether this is not a necessary and logical course to be followed. That station which is most progressive and gives the best service, judged always from the standpoint of the listener, will succeed. The neighboring stations which cannot do so well are not long in learning that their effort and expenditure is producing no advantageous result. It is well from all points of view, even their own, that they should go out of business; fortunately they do.

CONCENTRATION WITHOUT MONOPOLY

THE Class B stations, which now afford the widest and most dependable class of service, offer the most serious problem in interference. Any DX fan in the center of the country can safely boast that his set will reach from Orono, Maine, to Los Angeles, and from Winnipeg to Cuba, but his boast is true only when he speaks of Class B stations, for those of Class A rarely have sufficient power to be heard more than occasionally beyond a hundred miles.

In the Class B range there are built or building more than 100 stations, with only forty-seven wavelengths to be distributed among them. So now, on the average, there is less than one wavelength for each two stations, which means that many Class B stations must divide their time of operation. This division of time has led to much difficulty; but the Department, for the present at least, is allowing the problem to solve itself.

UNCLE SAM: HOTEL CLERK

THE Department in radio takes much the same attitude as the room clerk at a popular hotel. As evening approaches all of the rooms are engaged, yet there are numerous

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DR. J. H. DELLINGER AND D. B. CARSON

Dr. Dellinger is head of the radio laboratory of the Bureau of Standards, which, being a division of the Department of Commerce, works closely with the Radio Service. D. B. Carson is Commissioner of Navigation and is the general supervisory head of the Radio Service

demands for accommodations still to be met. In the radio Class B hotel, it is sun-down and all of the wavelengths are assigned. What does Uncle Sam, the radio room clerk, do? Just what the hotel clerk would do under the same circumstances.

The newcomer arrives and wishes accommodations. If he has a friend who will share with him his room, or Class B wavelength, the clerk welcomes him and makes this room assignment. He is glad to have each double bed filled with two paying guests. If a third friend arrives and the first two are willing to have a cot placed in the room, all are happy and are all accommodated. But if the late-comer does not find such a friend to accommodate him, obviously the clerk will not turn out one of his regular patrons to make room for the newcomer, nor will he insist that the earlier arrival share his bed, or wavelength.

Uncle Sam, in planning wavelength assignments in the Class B wavelength range, takes the same stand. As the Secretary of Commerce puts it, "The Department cannot give what it has not got." And it is perfectly clear that there are no Class B wavelengths left. Hence one can properly read between the lines of the Department's recent statement that *there will be no further assignment of Class B wavelengths* for the present or the near future. Nor will the Department willingly destroy the value of present wavelength assignments by demanding that they be shared with late-comers.

"S. R. O." AT THE BOX OFFICE

LET us go back again to the theater for comparison with the radio station. The early-comers, or those who bought tickets in advance, fill all the seats, yet there is a long line at the box office despite the sign "Standing Room Only." Uncle Sam, with no radio seats in the Class B orchestra, has hung out his "S. R. O." sign, too. But he will, in fact under the law he must, grant licenses and assign wavelengths. He does this by a ticket of admission which entitles the new broadcaster to work only in the Class A range, 205 to 280 meters. In this range he is not comfortably seated as a member of the radio broadcasting party. He finds himself standing behind the back seats, jostled by other late-comers, and seeing the performance at great disadvantage. But he is simply paying the penalty as a late-comer.

If some of the present Class B stations discontinue service or cease to give service adequate from the public point of view, their licenses, which are renewable every 90 days, will doubtless not be renewed for comfortable third-row aisle seats. In fact, Uncle Sam, just as the theater management, reserves the right to withdraw the admission ticket at any time. Hence a disorderly station, like a dis-

orderly spectator, will promptly find himself outside. As one leaves, another may be seated. The place he gets depends upon the appropriateness of location, service proposed, and wavelength thus made available.

THE CINCINNATI "ROW"

RECENTLY, a controversy over division of broadcasting time in Cincinnati was not promptly settled by the local Class B stations, two of which for several nights broadcast simultaneously on the same wavelength. The Department officials were asked in this and in one other similar case, "What are you going to do about it?" The answer was very simple, "Nothing."

If two stations insits on killing themselves and each other, the Department is perfectly willing that they should do so but it will not allow this situation to interfere with public service. Two such disorderly patrons of the radio hotel will be permitted to settle their controversy outside. The wavelength which they should have agreed to share peaceably will very promptly be given to someone else who will use it in the public interest.

Only one or two such examples will be ample to demonstrate to broadcasters that the public interest must be served. On no other basis can the radio broadcaster exist. On no other basis will he be permitted to retain his Class B license.

POLICING IS NOT CENSORSHIP

THE Department properly is insisting that each station maintain a certain technical standard of service and that it stay properly on its own wavelength. But the Department is equally emphatic that this is policing, not censorship.

Judge Davis explains that neither he nor any one else in the Department is willing to assume that they know enough to determine on behalf of the public what may and what

WHERE AMERICAN RADIO ACTIVITIES ARE CONTROLLED

The Department of Commerce building in Washington. Here, in the Bureau of Navigation, Radio Service offices, the administrative lines run to the entire nation. The Department controls every amateur operator with a transmitting station and every commercial ship and shore station, as well as the very host of broadcasters. The radio inspection staff and the appropriation supplied them has never been large enough so that the inspection duties could be adequately done

may not be broadcast. Whether such a station provides jazz or education, whether it runs from six o'clock to midnight, or from midnight to noon, is not defined or regulated in any way. The public is the judge, and the public makes its wishes known in no uncertain manner to the broadcast station which does or does not serve its needs or whims.

But providing all this power over the stations for the listener is not an easy matter, and at times the Department does not get undivided encouragement and support from the public. One difficulty which has been raised by the effort to protect the Class B wavelengths against undue crowding is the vigorous protest of some listeners that they cannot separate accurately all of the stations in the Class A group, the band from 205 to 280 meters. Naturally they cannot; and as crowding in that band becomes worse, the difficulty will be greater. But this crowding is in the public interest. It means that nine tenths of the useful wavelength area is reasonably safeguarded by suitable spacing between wavelengths and only one tenth is crowded. As the listener understands the great advantage of this, the Department hopes that it may gain even greater support for this idea. Certainly from the point of view of the public, nine-tenths of the radio loaf is better than none.

ALMOST since 1912 when the Department of Commerce was charged with the enforcement of the radio laws, and certainly since the advent of broadcasting, they have struggled along as best they could, making Herculean efforts to accomplish their tasks with the pitifully small staff and Congressional appropriation granted them. The radio affairs of the country are supervised from nine district offices. If each radio inspector had an equal territory, that would give each one five and one third states to look after. And in some district offices, an inspector and one or two assistants are expected to do all the work.

The recommendations of the radio conference, called in October, 1924, by Secretary of Commerce Hoover, were the consensus of the "best minds" of radio who were gathered there. It is generally agreed that the reason the changes suggested were not put in force was because the Department was so crippled in available funds and in personnel that any additional undertakings on their part were absolutely out of the question.—THE EDITOR.

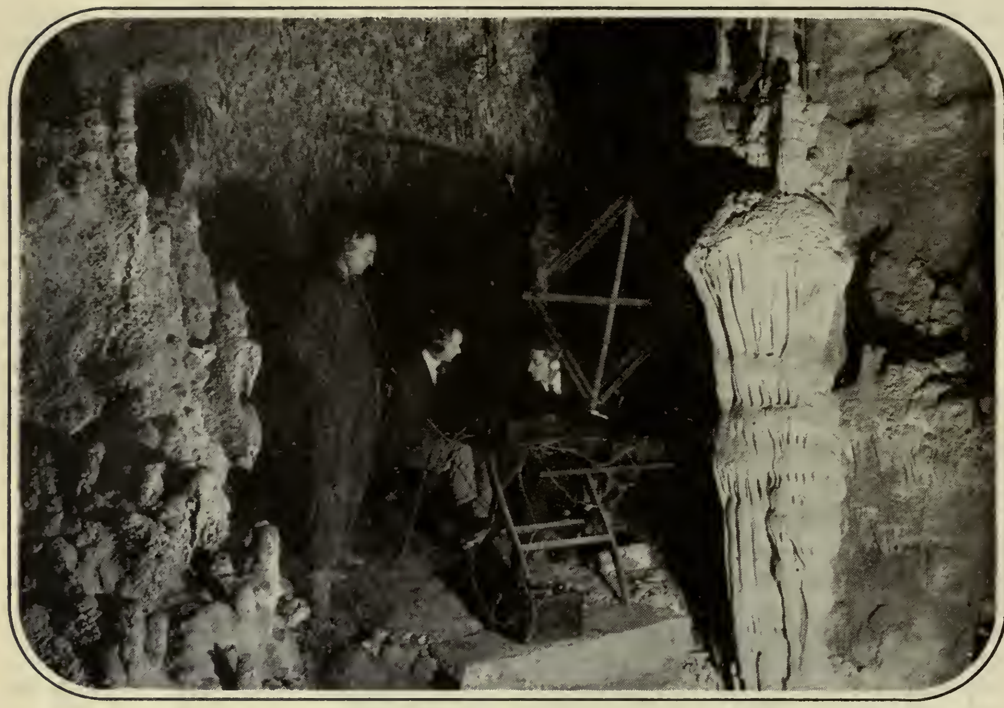
THE DISTANCE FIEND

HE WAS a distance fiend,
A loather of anything near.
Though WOOF *had a singer of opera fame,*
And WOW *a soprano of national name,*
He passed them both up for a Kansas quartet
A thousand miles off and hence "harder to get."
New York was too easy to hear.
He was a distance fiend.

He was a distance fiend,
His radio ruling his life.
When he and his family went to the play,
He'd take them to Yonkers instead of Broadway.
The show being over, he'd blow to a bite
In far Staten Island, that very same night.
God pities his daughter and wife,
He was a distance fiend.

He was a distance fiend.
Alas, but he died one day.
Saint Peter obligingly asked would he tell
His choice of a residence—Heaven or Hell?
He replied, with a show of consistency fine:
"Good sir, you have hit on a hobby of mine.
Which place is the farthest away?"
He was a distance fiend.

—A. H. FOLWELL, *in The New Yorker*



RADIO IN A VIRGINIA CAVE

Endless Caverns at Newmarket, Virginia. Experiments with radio reception have been tried in many unusual locations from coal mines to bank vaults, but it is doubtful if any radio equipment has been located in more picturesque surroundings

THE MARCH OF RADIO

By J. H. Morecroft

Past President, Institute of Radio Engineers

What Does the New Allocation of Broadcast Wavelengths Mean?

JUST why the Department of Commerce reallocated many broadcast wavelengths is not evident. "The Department of Commerce has been engaged for some time in an attempt to divide the ether more efficiently than has been the case hitherto," was the announcement from Washington. Here are some examples of the new assignments: WEAF 491.5 meters, instead of 492, WGBS 315.6 instead of 316, WJY 405.2 instead of 405, WHN 361.2 instead of 360, etc. These changes are so insignificant that just what is gained is not at all evident. Certainly no new channels have been created by such diminutive shifts from former wavelengths. The changes are so small that unless very careful observation was made before and after the change, the average listener would not realize that any change had been made. If for example, WJY tuned at 30 on a condenser dial before,

it will now tune at 30.03, but such a shift is much less than the width of one of the division marks on the dial. Most of the changes in the other well known stations are of equal insignificance insofar as the average listener is concerned.

The First Presidential Radio Inaugural

GREATER and greater become the radio audiences which are invited to attend the country's important events. When President Coolidge took the oath of office on March 4, the whole country was enabled to listen-in, and we must add, his speeches generally make very good listening. At least 21 stations participated in the broadcasting network, extending from Boston to San Francisco, and from St. Paul to Atlanta. This was the Telephone Company group and in addition, WRC, WJZ, and WGY of the Radio Corporation were tied in by their own wires.

It must give President Coolidge increased courage (if such were necessary) to reaffirm his stand for safeguarding the country's funds—this idea of realizing that he can talk directly to probably 15,000,000 of his countrymen.

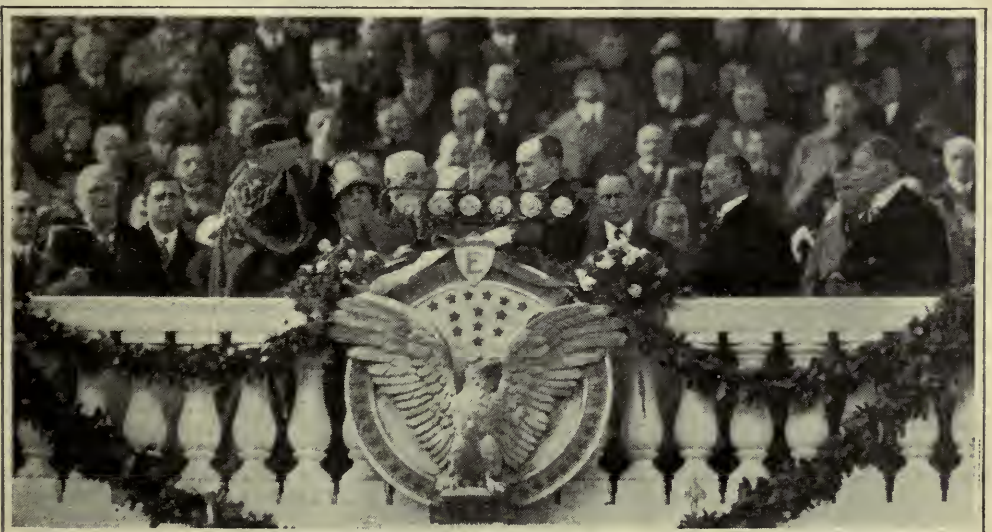
We hope that soon Congress will be forced to broadcast its activities. Verbose senators may have their activities somewhat rationalized and sobered if they realize that secret chamber procedure is no longer available to them. Not very many of them would care to vote in the affirmative to increase their own salaries immediately after the president had outlined his economy program—that is, they wouldn't care to if they knew that a few million of their constituents were listening carefully to their words.

What Membership in the Institute of Radio Engineers Means

FREQUENTLY we get inquiries about the status of some radio writer who signs himself "radio engineer" or some such title, or declares his status by giving membership in this or that society. It is perhaps pertinent to explain the significance of membership in the Institute of Radio Engineers. Insofar as we know, this is the only bona fide association of radio engineers in existence.

In its membership of about 2500, three grades are recognized, and the ranking of a member in one or the other of these grades gives a very trustworthy estimate of the man's standing in the radio profession.

Anyone of mature age who is actively interested in radio may become an Associate member of the Institute. The applicant has certain formalities to go through, such as filling out a regular membership blank giving his training, business, references, etc., but no difficult conditions are imposed to hinder him from becoming an associate member.



THE FIRST RADIO INAUGURATION

President Calvin Coolidge, taking the oath of office from Chief Justice William Howard Taft, of the United States Supreme Court. March 4, 1925, was the first time in American history that an ex-president administered the oath of office to an incoming president. The twenty-four stations which broadcast the ceremonies practically linked up the entire nation

ENGAGING A HOTEL ROOM AND RADIO

Is now possible at the Drake Hotel in Chicago, the Roosevelt in New York, and the Benjamin Franklin in Philadelphia. A portable set is installed in the room of the guest ordering it. Having an individual receiver allows the guest to select his own radio entertainment. In some large apartment houses, hotels, and hospitals a central receiver has been installed and the output is then wired to the various rooms. The disadvantage is that but one program can be heard at a time and little or no selection is offered the guest

The rank as Associate I. R. E. does not carry with it any certification by the Institute that the member is or is not a capable radio engineer.

To become a member of the Institute (Member, I. R. E.) a man must submit to the Board of Direction a record of his radio achievements. This record is carefully scrutinized by men who know the radio field well. Membership is given only if the man's record shows him to be a capable engineer of sufficient ability to carry out any ordinary radio project. Possibly one quarter of the total membership of the Institute have the rank of member and in this group will be found practically all those engineers who are responsible for modern radio development.

The Institute has for its highest grade of membership that of Fellow. This rank is bestowed only upon those few engineers who have proved themselves leaders in the radio field. Probably less than one twentieth of the total membership has been given this highest rank.

Radio a la Carte

THE Hotel Roosevelt, New York among others has installed a novel radio service. Instead of putting a receiving station on the roof and installing wires to the guest's room as has been done in some of the larger apartment houses in New York, the management of the Roosevelt has decided that the guests could be better served by putting actual radio sets in the rooms. To start the experiment, a dozen portable receivers with self-contained loop antennas have been purchased and are at the call of any guest. Presumably the management will see that the sets are maintained in good condition, and the guest has merely to ask for radio service, and a receiving set will be dispatched to his room at once and he may tune-in on any station he desires.

Broadcast Licenses Should Be Granted Only on Petition

AS CHURCHES, hotels, Elks, Klansmen, and apparently everyone else, scramble for broadcasting licenses, and get them, the question must occur to any one with common sense, where is it all leading to and why should the practice be kept up? What policy controls the Department of Commerce in issuing licenses? Or has it no policy? Is the real situation the same as the apparent one—that any one can get a broadcasting license who applies for it?

Apparently feeling that he owed the public some comment on the rapidly congesting condition of the radio channels, which is accumulating under his direct supervision, Mr. Hoover recently issued a long statement on the radio situation parts of which we quote:

> There are at present 563 broadcasting stations in operation, or under construction. The most difficult problem in radio regulation and development is the distribution of wavelengths in such a way as to prevent interference between stations. There are in all 86 different wavelengths available, if we keep the stations 10 kilocycles apart and stagger the assignment of wavelengths geographically so as to prevent overlap in the area of effective reception.
>
> The recent experiment of the Department in attempting to increase the number of channels by decreasing the difference to 7 kilocycles proved unsuccessful with the present development of radio receiving apparatus.

All through the lengthy document we searched to see if Mr. Hoover did not expect some time to lessen his license-issuing activities. There is no mention of it. It looks as

though the Secretary thought he had no discretionary power in withholding permission from the new stations, or else that he greatly feared to use it, but that conclusion scarcely seems justified in view of the personality of the present Secretary.

According to one of the writers in the New York *Times*:

> There is difficulty in seeing just what excuse there is for granting the broadcasting privilege to one applicant and denying it to others equally reputable. Nevertheless a justification for drawing the line somewhere on mere numbers of grantees must be found if radio is to progress toward the realization of its possibilities, or if it even is to retain those which it now demonstrates.

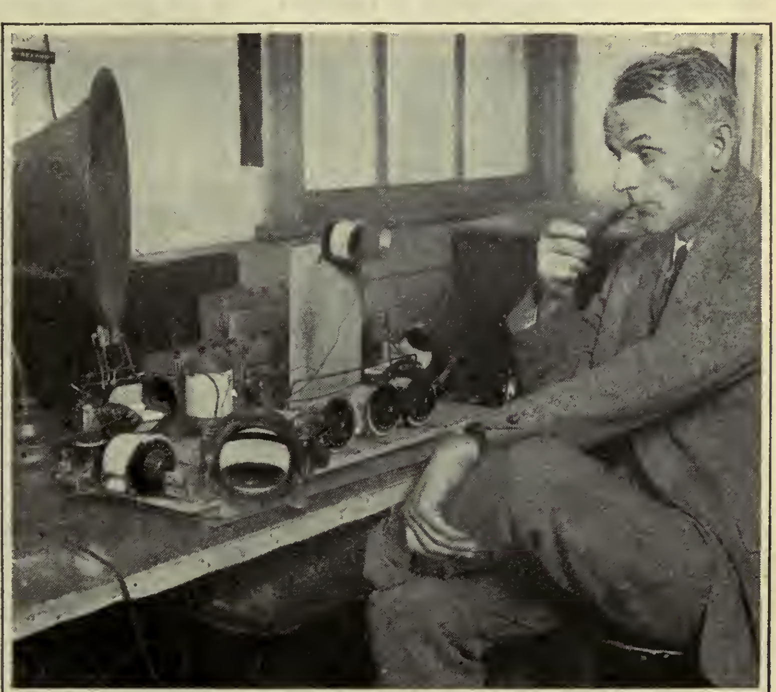
Some time soon Mr. Hoover will have to say "No, I cannot see that the interests of the radio listener will be served by granting you a license, so I must decline to issue one to your anticipated station." It seems as though someone is missing the real idea of radio's possible progress. The issuance of a license should not depend upon either precedent, favor, standing of the applicant, fear of embarrassment, or any other item of this nature. As many of our correspondents continually point out, the question Mr. Hoover has to ask himself is, Do the listeners want this proposed station? If they don't want the station then the license should not be granted.

We venture to suggest that a new applicant be obliged to accompany his request for a license by a petition, signed by at least 100,000 people who live within, say 50 miles of the site of the proposed station. The number of required petitioners should depend upon the locality—around Chicago and New York it might well be 1,000,000, and in sparsely settled country, possibly 50,000 or less. This procedure would decide the question just as it should be decided—in the interest of the radio listener.

Will the British Receiver License System Fail?

WE HAVE mentioned once or twice that if this government should ever decide to take over radio broadcasting and should attempt to maintain the service by collecting revenue from the listeners in the form of a tax or license, it would require a tremendous force of collectors with hundreds of thousands of warrants, to make the collections good. We think that the broadcast listener does not want to be licensed, and if the good American public does not want to pay a license fee, it probably won't. The nation has been told to stop drinking intoxicating liquor for some years now, but hasn't yet agreed to submit to a ban on what is still regarded by many as a "legitimate," even though unconstitutional, privilege.

There are several countries where license fees from the listeners are depended upon for maintaining broadcast service, among them, England. We can safely say that the Eng-



ROY A. WEAGANT

Chief Engineer of the De Forest Radio Company, at work on a receiver circuit in his laboratory

lishman is a more law-abiding citizen than we are. The Post Office authorities, who have the task of supervising British radio, estimate, says a news dispatch, that there are 2,500,000 pirates, who have listening sets but who have not paid the government fee. A bill is urged to permit drastic punishment for these ether robbers. Twelve months' imprisonment or $500 fine has been suggested. Even should such a measure be enacted, trouble would still be encountered because before entering a man's house a warrant is required, and the promiscuous issuance of search warrants would certainly arouse a tremendous antagonism in a land where every man's cottage is supposedly still regarded as his castle.

If there really are 2,500,000 radio pirates in England, it doesn't augur well for the license system of control. If these reports are accurate, it looks as if the license system in England is doomed to fail in the very near future.

Radio Quality Will Count

AS WE glance through the radio advertisements each month, it is only too plain that many radio firms, like Kipling's ships, "pass in the night." Many a man who knew nothing whatever of the radio game, was persuaded by some overenthusiastic adviser that "mints of money" were to be gleaned from the radio public. All one had to do was to get something which sounded like radio and then spend lots of money on advertising. After that it was to be nothing but a matter of counting profits. These inexperienced radio adventurers are the ones who come and go—but few of them last to enjoy the confidence of the radio public.

As these bargain-apparatus firms start up with apparently a tremendous price slash over the older and more conservative firms dealing in the same line of goods, it must frequently seem to these manufacturers that their sales are due for a slump. But they don't slump and if the quality is maintained high, they won't. New as radio is, people already realize that the apparatus with a name behind it is probably worth more than the nameless waifs with which the irresponsible store has its shelves loaded. A reliable firm name means much in the paint, steel, or tool business. Conservative radio firms, whether they manufacture panels, binding posts, condensers, or what not, will soon start to reap the benefit of their reputation. It probably won't be very long before the radio public learns to buy "by the name" rather than "by the price."

THE WRITING ON THE WALL

During the presentation of a radio play in an English broadcasting studio. The typewritten pages of the manuscript were projected on a screen on the studio wall where all could see it. The microphone, English style, is enclosed in the rectangular box in the center

Vacuum Tubes in Another Legal Tangle

ABOARD THE S.S. "GEORGE WASHINGTON"

Captain Cunningham has a broadcast receiver which he uses in the time he can spare from his nautical duties. Captain Cunningham was navigator of the U. S. A. T. *Leviathan* during the War. From left to right, Captain Cunningham, W. J. Roche, and T. H. Rossbottom

JUST before the De Forest audion patent expired, the attorneys for his company brought about an action which had a startling effect upon the Radio Corporation subsidiaries. In the United States District Court at Wilmington, Delaware, Judge Hugh M. Morris, granted an injunction which stopped the Radio Corporation's sale of tubes manufactured by the Westinghouse Lamp Works. The case involved nothing of direct interest to the radio listener. It seemed merely to be a legal squabble.

When one stops to think of it, the legal profession seems to be the most inbred union in existence. You have to be a lawyer to make a law, and you have to be a lawyer to prove that someone else is breaking a law. Furthermore, one can't become a lawyer unless the rest of the union wants him, because the lawyers write the entrance examination for the union. One set of lawyers draws up a legal document to permit a lamp company to manufacture vacuum tubes and another lawyer hails them into court to show that their law was bad. It appears that the De Forest agreement which would permit the Westinghouse Electric and Manufacturing Company to manufacture tubes would not permit the Westinghouse Lamps Works to do so, even though it is acknowledged by all that the Lamp Company is simply that part of the Westinghouse Company which had the facilities for making tubes. The Manufacturing Company is equipped for making motors and all kinds of electrical machinery, but not for turning out delicate lamps and vacuum tubes, and so naturally turned its tube activities over to the lamp division. Judge Morris ruled that, even though the parent company had the right to manufacture tubes, the Lamp Company had no such right and all the tubes it had wrongfully manufactured must be confiscated and held.

So the lawyers go, one getting a company into trouble, so that another can get it out. It looks as though in this case the attorneys for the De Forest Company have been a little bit shrewder than those of the Radio Corporation.

Radio Dispute in Cincinnati

THE ever increasing number of broadcasting licenses issued by the Department of Commerce is practically certain to bring trouble in a short time, in ever increasing amounts. Some method of equitably limiting the number of stations must be found by the Department. It is their job and they might just as well tackle it now.

A strange instance of the Department's inactivity took place in Cincinnati. Two stations in that city had been granted licenses to operate on the same wavelength. After much squabbling as to the proper division of

time, they finally did operate on the same wavelength—at the same time! It was reported from Washington that the Department of Commerce had been repeatedly asked to step in and settle this impossible situation but had declined on the ground that to set such a precedent would get the Department hopelessly enmeshed in a maze of disagreements between stations.

One might well ask the Department how it did expect such disputes to be settled. It is a strange idea of privilege and duty which consents to the issuance of broadcasting licenses to any who want them and then when trouble comes to the listening public as a result of the excessive number of stations, to turn one's back and let someone else settle the trouble—trouble directly due to the Department's freedom with its licenses. Who, we may well ask, does Mr. Hoover think will step in to straighten out such troubles between the various stations, if his department thinks the task too onerous?

Making Radio Transmission Surer

IN A recent talk before the American Institute of Electrical Engineers, Mr. Alexanderson, chief consulting engineer of the Radio Corporation, gave a general description of their network of channels which is being rapidly extended over the earth. After outlining general troubles and difficulties which an engineering audience could well appreciate, the speaker went more into detail to show how the Radio Corporation was continually working to increase the certainty of communication over their radio links. He spoke of the remarkable wave antennas used at Riverhead, over which signals from all the stations in Europe are received. Although static has not been annihilated by the R. C. A. engineers, this reception scheme of theirs ensures communication unless there is a severe local thunderstorm. To obviate the possibility of such a storm interfering with transatlantic channels, another receiving antenna has been fitted up in Maine, so that either can now be used, depending upon where the atmospheric disturbance is least.

He spoke of new features in short wave transmission, a so-called high-angle beam. If one could rely upon his rather scanty description, it appears that he thinks it may be possible to send short wave energy from one place to another by some kind of beam system which is directed high up in the air, to come down at a desired spot by reflecting from the earth's upper conducting atmosphere. This story reads more like a poet's dream than like an engineer's narrative, so don't give it too much credence as yet.

It may be possible to send beams of energy high up in to the sky and so around the Heaviside layer, but it is more likely that such an effect will be found in England than here. America has done practically nothing with directed beam transmission, but Marconi and Round seem to be progressing continually along just these lines.

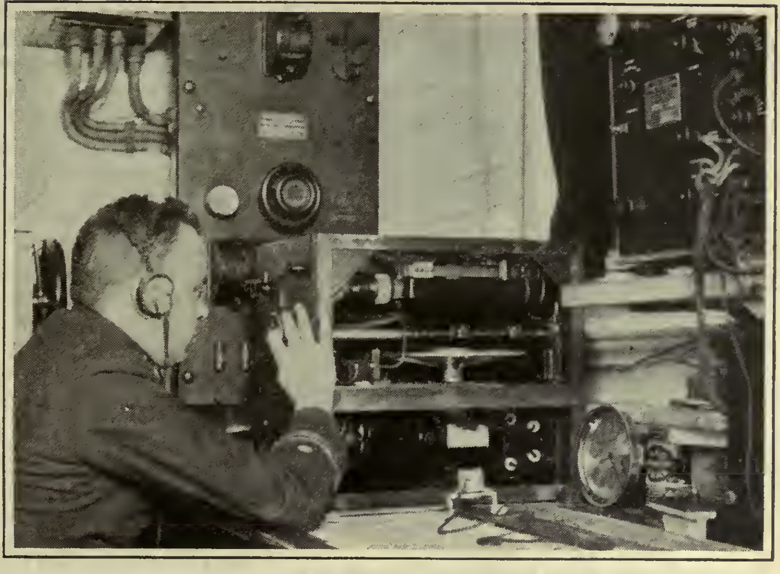
If directed beams sent high into the air actually get much farther than those sent along the earth's surface they would probably have found out and reported it to us long ago.

LAYING A ROGERS UNDERGROUND ANTENNA

At Hyattsville, Maryland. Dr. J. Harris Rogers is nearest the camera. The Rogers system has been developing experimentally for some time and has been watched by officials of the War and Navy Departments

The Day of Good Music

VERY recently a most welcome announcement was made by Mr. John A. Holman, broadcasting manager of



CHARTING THE DEPTH OF THE PACIFIC OCEAN

With the sonic depth finder, a new application of well-known radio principles. The apparatus projects a vibration which follows through the water to the ocean bed; it is then reflected back. The elapsed time is measured from which the depth of water can be calculated. Lieut. Clore of the U. S. S. *Pioneer* is shown in the radio cabin of his vessel operating the depth finder

station WEAF. The public's demand for jazz has greatly decreased, he asserts, as evidenced by the letters received from the station's listeners. Of the many thousands of listeners who now write in, by far the most want good music, he says; and thanks be, say we, that the managers are waking up to the fact that the whining, croaking, saxophone with its associated agony-producing pieces of barbarism, are due for the discard, as far as the radio listener is concerned.

Mr. Holman evidently thinks there has been a change of appreciation on the part of the listeners, but we doubt this very much. The letters no doubt indicate such to be the fact, but it seems more likely that the admirer of jazz would write enthusiastic letters to the broadcaster more often than a lover of Chopin and Mozart. The appreciator of jazz is the one who makes the most noise, just as a dozen wild American-Irish would make enough noise against such a speaker as Mr. Lloyd George to drown out the approbation of the remaining 2000 in the audience. This has probably been the case with the radio audience—those who wanted good music are the quiet type who suffered much and long before remonstrating against the finally unbearable monotonies of much of the modern jazz.

What the Radio Corporation Did in 1924

SEVERAL points in the annual report of President Harbord of the Radio Corporation for the year 1924 demand comment. We think it is only fair to give the Radio Corporation credit for being the first to inaugurate broadcast concerts by well-known phonograph recording artists. The idea, which was later taken up by the American Telephone and Telegraph Company with much success, originated in an agreement between the Radio Corporation and the Brunswick-Balke-Collender Company. This innovation in broadcasting programs was an inspiration, and it is a pleasure to record our appreciation of its inception.

In speaking of the value of the radio business, General Harbord made the interesting statement that for every dollar spent on musical instruments of all kinds, phonographs, pianos, and organs, seventy-five cents was spent on radio. Radio business was about three-quarters that of the entire jewelry business of the United States.

In transoceanic traffic, radio carried between twenty and thirty per cent. of European traffic, and fifty per cent. of the trans-pacific messages. Apparently the proportion of radio to cable messages is not changing very rapidly, as it is our recollection that about the same proportion existed during the previous year.

Radio Raises Cable Earnings

INSTEAD of taking business away from the transoceanic cables, the development of radio appears actually to have put money into the coffers of the cable companies, according to a statement of Clarence H. Mackay. Mr. Mackay says that the Commercial Cable

E. F. W. ALEXANDERSON

Schenectady; Chief Consulting Engineer, Radio Corporation of America

"There is a large and growing group of amateurs who pursue radio for the love of the art. The art to them is not the performance in the studio but the technical art of radio itself. Radio has enjoyed a greater following of amateurs than any other branch of engineering, and it is the thought of these amateurs that moulds the future. They are one step closer to reality than the imaginative writers, like Kipling and Jules Verne, who give us glimpses of the future long before they can be realized. The amateur likes to anticipate what advances in the art may reasonably be expected within the next decade"

Company had handled more business over its cables in 1924 than during any previous year of the company's existence.

The changing economic situation in Europe was reflected in a growing demand for cable service, and as for radio's encroachment on the cable's territory, Mr. Mackay says "on the contrary, the radio has actually stimulated the use of electrical communication between the continents, and of the new business so created, the cables are really getting more than their proportionate share."

Mr. Sarnoff As An Optimist

SEVERAL times during the last decade the press has chronicled that someone had laid low Demon Static and that hereafter, by the application of some heavenborn device, radio was to be freed of troublesome atmospheric disturbances. Too well now, we know that these were all illusions.

But now Mr. Sarnoff, General Manager of the R. C. A., strikes an entirely different note when mentioning static. At a recent dinner he ventures the opinion that static, after all, is not an unmixed evil.

I often wonder, whether the same minds saw the limitations of radio telephony because of the lack of secrecy, and now see a limitation of radio because of static, might not be disappointed to wake up some morning in the future to find that the static, which is all-pervading, represents a great and free gift of nature to man, who may yet learn to harness that energy, get it from the air, and make it do a great work for man.

Not seeing through the same rosy-hued glasses as does the speaker on this occasion, we venture that the man who gets static out of the air, no matter what he does with it after he removed it from the radio realm, will already have done a great work for man.

Incidentally, Franklin with his kite did show us exactly how to do this thing quite some years ago, didn't he?

Interesting Things Interestingly Said

DR. WILLIS R. WHITNEY (Schenectady; director of research for the General Electric Company): "We are building a $150,000 laboratory to be devoted to research in the field of directional radio and short wavelengths. Our experimenters have obtained results on wavelengths on less than fifty meters. We can't yet explain why such waves travel as far as they do, with relatively weak impulses behind them, or why they should have passed, unaffected, through the belt of darkness produced by the eclipse, while the longer wavelengths were either accelerated or deflected. . . .

We can look for the transmission of power by radio if we are satisfied to use 99 per cent. of our power in transmitting the other one per cent. It is a matter of cost. So long as it is cheaper to send power over wires, there is no incentive to send it over the air. The ordinary radio transmitter sends power through the air, though in relatively small quantities. It may be more economical to send power through the air for operating a powerhouse switch than to send a man to do it."

THE REV. FATHER JOHN HANDLY (Society of the Paulist Fathers, New York): "The thing that impressed me along the lines of my daily work in collecting money for the new Paulist League broadcasting station was the fact that our Divine Lord was describing a scene very familiar to me in the parable of the Sower and the Seed, because I was reared on a stony briar-choked farm down in Tennessee. . . . There are many who are doubtful about the value of radio as a means of teaching reli-

gion. I want to call their attention to this point—that our Lord thought it worth while to broadcast the Word of God in spite of the fact that some of the seed fell by the wayside. . . . He thought it worth while because he hoped some would fall on good ground and bring forth fruit."

WILLIAM A. FISCHER (Boston; in a recent paper read before the Music Teachers' National Association in St. Louis): "Radio listeners in this country are tax free and have been trained to expect a startling variety of entertainment for nothing, while broadcasters have been, and still are, placing their dependence on performers and speakers who give their services without pay in their eagerness for publicity. Thus a vicious circle has been started. Until artists worth paying for are regularly engaged, radio concerts, with exceptions, will continue to be merely a source of advertising to immature performers who, instead of helping the public to enjoy good music, often cast opprobrium on it by their inadequate and inarticulate performances."

ROBERT L. COX (New York; second vice-president, Metropolitan Life Insurance Company, speaking of the Company's plans for broadcasting setting-up exercises through WEAF, WJAR, and WEEI): "While radio itself is no experiment, the use of it for teaching health is still in the developmental stage. We are going to give the radio audience what they want in this respect, but we don't propose stopping with the letters. We have other means of finding out what people want. . . . Through our agents, we shall be able to make a house-to-house canvass and learn what the radio fans think, not only of our health messages and exercises, but of radio programs in general."

ROBERT H. RANGER (New York; engineer, Radio Corporation of America; in charge of development work of the Radio Corporation system of transmission of photographs by radio): "For eighty years a thousand or more investigators and certainly millions of dollars have been concerned in the attempt to transmit pictures successfully at a distance. Economics enters into the problem as much as mechanical and electrical design. In the photoradiograms transmitted across the Atlantic in December, we narrowed them down to a kind of sketchy, shorthand form, because of the economic factors of time, power, and cost, all of which are highly important in picture transmission. . . . The response accorded photoradiograms, which was far greater than those of us who have been concentrating on prosaic long-distance wireless telegraph communication ever expected, has greatly encouraged us in our efforts to refine and improve the transmitted picture."

RUDOLPH H. WURLITZER (New York; manufacturer of musical instruments): "Our company believes that radio will develop the musical taste of the people of the United States more rapidly than if radio had not existed. We regard our sales, totalling $14,782,576 during a nine-months' period when radio was mounting in popularity, as compared with $13,653,809 during the same period in 1923, as significant. It is estimated that more than thirty million people in this country play some musical instrument. When such a large population of players have their natural human interest in music stimulated by the radio programs, an increased demand for musical instruments is not at all surprising."

MARTIN P. RICE

Schenectady; Director of Broadcasting, General Electric Company

"The Department of Commerce is now embarrassed by the number of broadcasting stations desired in comparison to the number of wavelengths available. A reallotment of wavelengths is now in progress in the hope of improving conditions for the radio listener. It would be highly desirable to provide an exclusive wavelength for each station operating with sufficient power to reach across the continent and having programs of national interest. Such a plan would increase materially the reliability of long distance broadcast reception and the increased range would stimulate the large stations to strive for the best in programs. Progress along these lines would not restrict the development of the strictly local stations designed to reflect the community life of their own districts. Such stations, operating on another band of wavelengths, have their own function and they may, on occasion, be tied into the general or national group by means of wire lines or radio rebroadcasting"

THIS ADVERTISEMENT is a "tabloid History of American Civilization; a capsule critique of the Higher Learner in these U. S. A.; it appeared in the Shreveport *Journal*," comments F.P.A. in the New York *World*. The advertisement:

ONE SET HARVARD CLASSICS, 51 Books, new, for Radio Receiving Set. Box 634, *Journal*.

How to Design Radio Coils

A Simple Non-Mathematical Method Which Can Be Applied by Any Radio Constructor

By HOMER S. DAVIS

ONE of the most frequent problems confronting the amateur radio builder is the design of the inductance coils of a new receiver. Often the size of tubing or kind of wire specified by the designer is unobtainable, or one may prefer to re-design a coil to conform to the principles of low-loss design. "Cut and try" methods are crude at best, and if the amateur has some means of easily computing the inductance of a coil, he can save both time and expense by its use.

The solenoid, or single-layer winding, is a common form of coil, and it is rather generally agreed to be the most efficient for a given value of inductance. But although the simplest to design, the formula for a solenoid is rather difficult to use unless one is quite familiar with mathematics. Fortunately, there are several methods of representing formulas graphically, and of these, the alignment chart is probably the easiest to use, and therefore offers the best solution to our difficulties. A pencil and a ruler are all that are required to use these charts.

A discussion of the manner in which they were worked out is given below for the benefit of any who may care to follow it through, although it is not in any way essential to the use of the charts. The reader may skip entirely over this discussion if he so desires.

The formula for the inductance of a single-layer solenoid is:

$$L = .02507 d^2 n^2 l K$$

where L represents the inductance in microhenries, d the diameter in inches, n the number of turns per inch, l the length of the solenoid in inches, and K the shape factor. The latter depends upon the ratio of the diameter to the length, and its value may be obtained from tables in the Bureau of Standards Bulletin No. 74 and elsewhere. Thus it is not especially difficult to solve for the inductance of a coil when d, n, and l are known. But the factor K causes no end of trouble when we try to use the formula in the reverse direction, solving for l, since K is then an unknown also. Cut and try methods must be resorted to. We can express K in a formula in terms of d and l, but the relationship is not simple. However, in most cases, the value of the ratio $\frac{d}{l}$ lies between $\frac{1}{2}$ and 2, and between these limits we may express K as approximately: $K = 0.674 \left(\frac{d}{l}\right)^{-0.293}$

Substituting this in the first formula, we have:

$$L = .0169 n^2 d^{1.707} l^{1.293}$$

and K has been eliminated. It is now possible to solve for any one value when the three others are known. It is still a formidable looking equation, but it may be charted with ease. It is hardly necessary to explain here how the charts are constructed, but suffice it to say that they are based upon the same theory as the slide rule, which was described in the "R. B. Lab." department of the January 1925 number of RADIO BROADCAST.

A Coil Calculator

Is what the chart which accompanies this article of Mr. Davis's, really is. Any number of constructors who tried to build a radio set from directions have been stopped short by their inability to secure a certain size coil and had no way of calculating its size, except by mathematics. And mathematics, to many of the radio constructing gentry, is not a desirable part of the picture. Many of the advanced radio calculations lead one directly into the calculus. Those who wish nothing more than a good rule-of-thumb will find the chart will allow them to build coils to the specifications of the various construction articles, will allow them to build a coil to attain a certain wavelength range with a condenser of given size, and by reversing the process, it is possible to find out what size condenser should be used with a given coil to attain a known wavelength. The chart and the wire table should be of great help to the builder of sets.—THE EDITOR

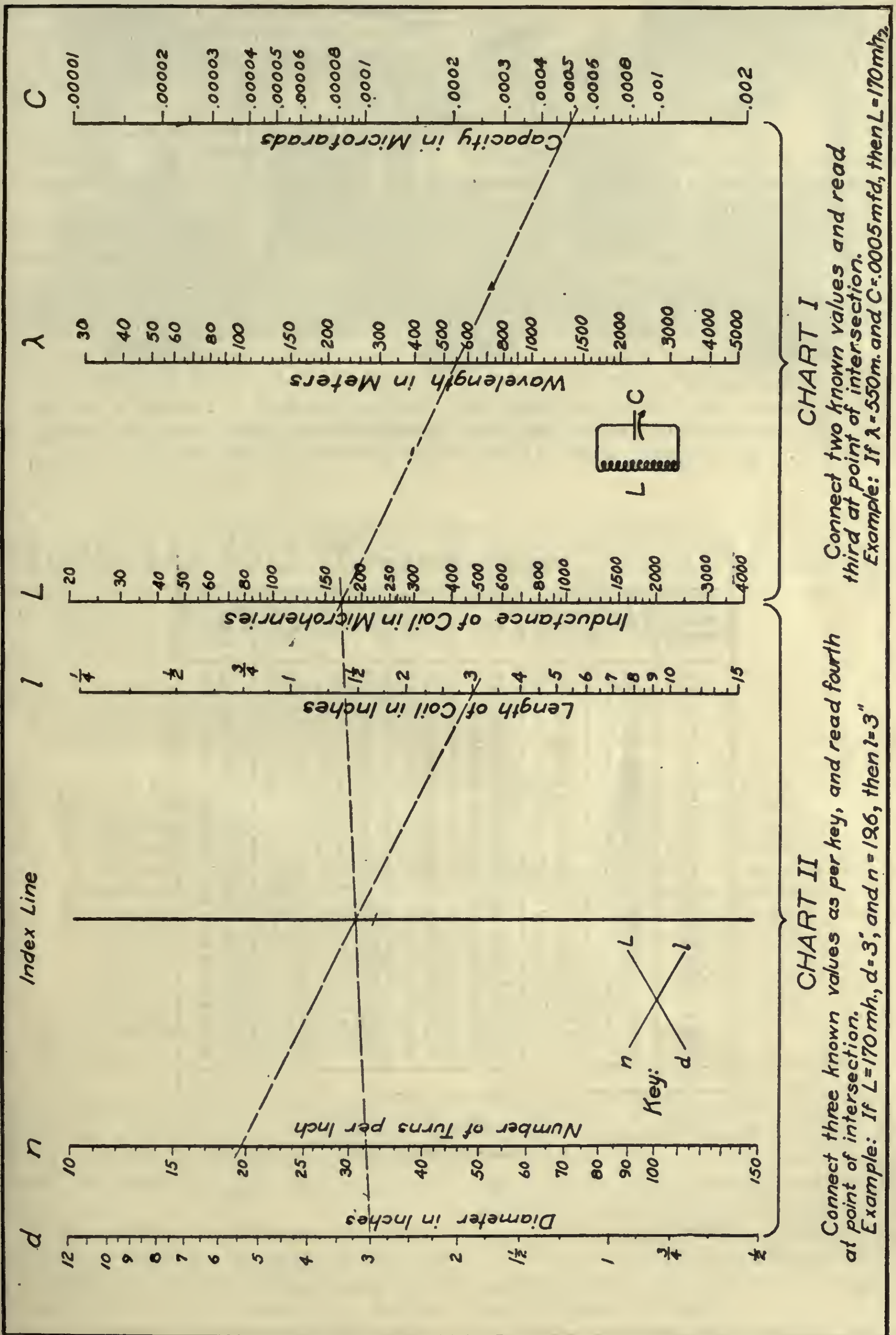

C
Capacity in Microfarads
λ
Wavelength in Meters
L
Inductance of Coil in Microhenries
l
Length of Coil in Inches
Index Line
n
Number of Turns per Inch
d
Diameter in Inches
Key:
CHART I
Connect two known values and read third at point of intersection.
Example: If λ=550m. and C=.0005mfd, then L=170mh.
CHART II
Connect three known values as per key, and read fourth at point of intersection.
Example: If L=170mh., d=3", and n=19.6, then l=3"

FIG. I

The formula from which Chart 1 was constructed is

$$\lambda = 1884\sqrt{LC}$$

where λ represents the wavelength in meters, L the inductance in microhenries, and C the capacity of the tuning condenser in microfarads.

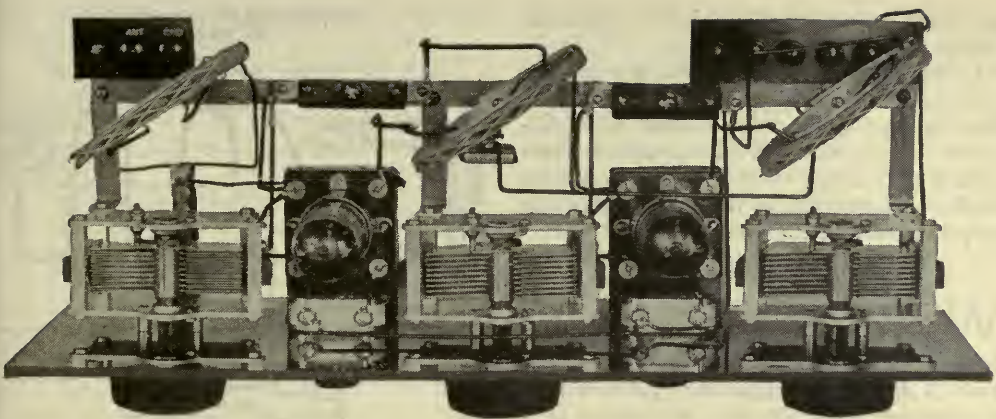
Referring to Fig. 1, it is seen that the two charts have been placed side by side, with the L-scale in common. As an example of the use of these charts, let us say that we wish our tuned circuit to reach a maximum wavelength of 550 meters, and that we plan to use a .0005 mfd. variable condenser tubing three inches in diameter, and No. 18 d. c. c. wire. With a pencil and ruler we draw a line from .0005 on the C-scale through 550 on the λ-scale, until it intersects the L-scale, reading 170 mh., as the required inductance of our coil. Another line is drawn from L = 170 to d = 3. Referring to the copper wire table, Fig. 2, we find that No. 18 d. c. c. wire can be wound 19.6 turns to the inch, so we draw a third line from this value on the n-scale, through the intersection of the second line and the index line, until it intersects the l-scale. This shows us that the coil should be wound to a length of three inches, and the product of n and l gives 59 as the number of turns required.

The chart may be worked in the reverse direction in exactly the same manner, always making sure that the correct pairs of scales are connected together.

The amateur builder will find many uses for these charts. In addition to their value in designing inductances for a new receiver, they may be used to redesign a coil for different sizes of tubing, wire, or tuning condenser than originally specified.

	KIND OF INSULATION						
B. & S. GAUGE	DCC	SCC	DSC	SSC	ENAMEL	ENAMEL AND SCC	ENAMEL AND SSC
14	13.7	14.6	14.7	15.0	15.2	14.2	14.7
15	15.0	16.2	16.4	17.0	17.0	15.8	16.5
16	16.7	18.0	18.2	19.0	18.7	17.6	18.4
17	18.5	20.0	20.0	21.2	21.4	19.5	20.5
18	19.6	22.3	22.3	23.6	24.0	21.7	22.9
19	22.5	25.0	25.2	27.0	27.2	24.2	25.8
20	24.5	27.5	27.5	29.5	30.1	26.5	28.4
21	27.5	30.8	30.8	32.8	33.6	29.6	31.5
22	30.0	34.0	34.0	36.6	37.7	32.7	35.0
23	32.7	37.5	37.5	40.7	42.3	36.1	39.0
24	35.5	41.5	41.5	45.3	47.2	39.7	43.1
25	38.5	45.7	45.7	50.3	52.9	43.7	47.9
26	41.8	50.2	50.2	55.7	59.0	47.8	52.8
27	45.0	55.0	55.0	61.7	65.8	52.1	58.1
28	48.5	60.0	60.0	68.3	73.9	57.0	64.4
29	52.0	65.5	65.5	75.4	82.2	61.9	70.6
30	55.5	71.3	71.3	83.1	92.3	67.4	77.9
31	60.0	77.3	77.3	91.6	103.0	72.8	85.3
32	62.7	83.7	83.7	101.0	116.0	79.1	93.9
33	66.3	90.3	90.3	110.0	130.0	85.6	103.0
34	70.0	97.0	97.0	120.0	145.0	91.7	112.0
35	73.4	104.0	104.0	131.0	164.0	98.8	123.0
36	77.0	111.0	111.0	143.0	182.0	105.0	133.0
37	80.3	126.0	126.0	155.0	206.0	113.0	146.0
38	83.5	133.0	133.0	168.0	235.0	120.0	157.0
39	89.7	140.0	140.0	181.0	261.0	128.0	172.0

FIG. 2
Wire turns per linear inch



RADIO BROADCAST Photograph

OVER THE TOP

A layout view showing the actual scarcity of wiring. The angle of placement of the coils is clearly indicated

How to Build a Two-Stage Radio-Frequency Amplifier

By JOHN B. BRENNAN

THE amplifier described in this article incorporates some new and desirable ideas in construction. Leads have been reduced to the shortest possible length, the famous Roberts system of double-wound coils has been used for the neutralization of each stage, and the especially efficient diamond weave coils employed for the transformers. This unit is simply a radio-frequency amplifier which can be connected to any detector. A later article will describe a detector and audio-frequency amplifier which may be used with it. In these days of high power broadcast stations, the selectivity gained by the use of radio frequency amplification is especially desirable. By completely neutralizing both stages of this amplifier, the full gain from each tube is secured. The simplicity of design and the ease of construction of this unit, in addition to its important feature of non-radiation, should appeal to every constructor.—THE EDITOR

BEFORE dealing with the construction of a radio-frequency amplifier it is well to understand just what radio frequency energy is and how it may be amplified.

The signal radiated by a broadcast station is composed of many electromagnetic vibrations or alternations. Due to many causes, such as the power of the transmitting station, absorption losses, location of the receiver, etc., these impulses which are collected by the receiving antenna may be too feeble to actuate the detector tube. When this is the case, little or no rectification in the detector tube takes place, making it impossible for the signal to be heard. To state the case simply, the detector tube performs the function of rectifying and making audible the very high or radio frequencies which cannot be sensed by the ear. This tube, so to speak, transforms or lowers the radio-frequency currents to an audible or audio-frequency current.

The vacuum tube can function as an amplifier (or repeater,) and it is possible to strengthen the amplitude of the very feeble received signal from the antenna, by means cf

a radio-frequency amplifier, before it reaches the detector.

Contrary to the general belief, the original signal potential is not passed along and amplified in these successive stages of radio-frequency amplification. The action in these units is more on the order of a trigger releasing device. To understand this, the action of an amplifier must be observed.

THE TRIGGER ACTION OF THE TUBE

WHEN a signal is applied to the grid of an amplifying tube, the electronic emission from the filament is interrupted in its path to the plate because the grid acts as a shutter or trigger device. By means of a local source of potential (the B battery), the variation in signal frequency is faithfully reproduced in the plate circuit of the tube in the form of a varying, direct current potential many times greater in strength than the original signal applied to the grid of the tube.

In other words, the vacuum tube has repeated and amplified the incoming signal without changing any of its characteristics.

We have so far traced the action in this circuit to the plate circuit of the first tube.

A typical two-stage radio-frequency amplifier with detector and one-stage audio amplifier is shown in Fig. 1.

Now in this plate circuit is contained the primary coil P2 of the radio-frequency coupling unit. This unit, consisting of the primary and a secondary which is connected to the input of the next tube, performs the function of inductively coupling one tube circuit to the next so that the signal received by the antenna may be repeated at a greater amplitude in each successive stage. In this instance, the unit is a radio-frequency transformer.

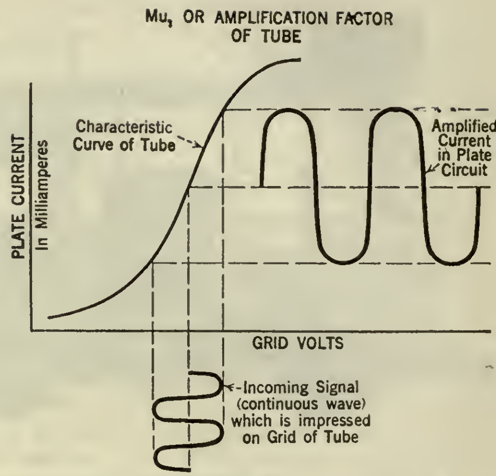


FIG. 2

How a tube amplifies, graphically shown. This only takes into consideration the amplification factor of the tube. Actually, the amplification is greater, due to the step-up value of the r. f. coupler unit

When the variation of current takes place in the first plate circuit, coinciding with the variation of frequency of the received signal, an electro-magnetic field is set up in and about the plate coil, the intensity of which varies with the variation of the plate energy. This varying magnetic field induces in the secondary of the transformer, which is the grid coil of the next tube, a magnified voltage corresponding exactly to that to be found in the preceeding plate circuit. (The direction in which the current flows in the two coils is

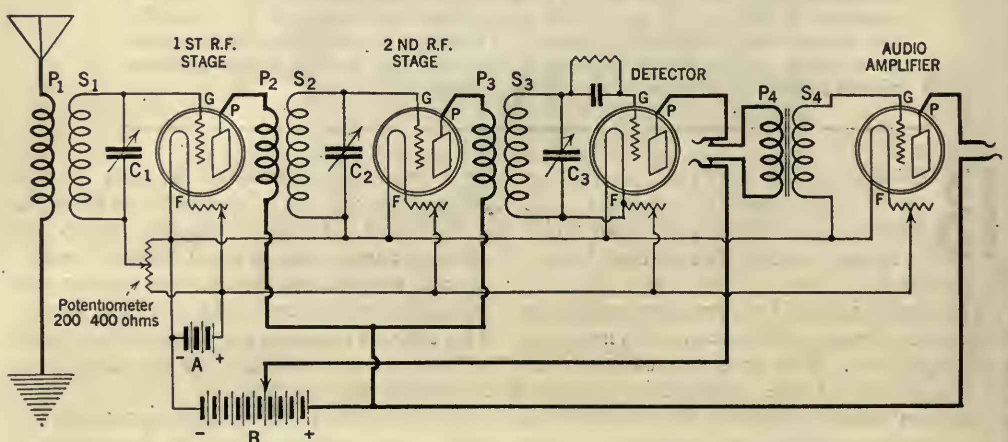


FIG. I

A typical radio-frequency amplifier circuit. Oscillation control is obtained by the potentiometer

opposite, but, for our present study, that fact makes no difference.)

Then, of course, the magnified signal is applied to the grid of this second tube and the entire tube action is repeated again, and so on for each successive stage. See Figs. 2 and 3.

The variable condensers C1–2–3 shunted across the various secondaries are employed to tune the circuits to the wavelength of the received signal. For this reason the unit P2, S2 and C2 in combination, is called a tuned radio-frequency transformer. We may sum up then by saying that in action, a radio-frequency amplifier will magnify the feeble antenna vibrations which ordinarily would not be strong enough to actuate the detector tube.

While radio-frequency amplifiers do, to a certain degree, increase the volume of a receiver, their main function is to amplify feeble radio energy which comes from great distances. This is the way in which a radio-frequency amplifier will increase the receiving range of a radio receiver. Such an amplifier will not, as a rule, increase the volume of signals which are already strong enough to be heard well.

THE DESIGN OF AN AMPLIFIER

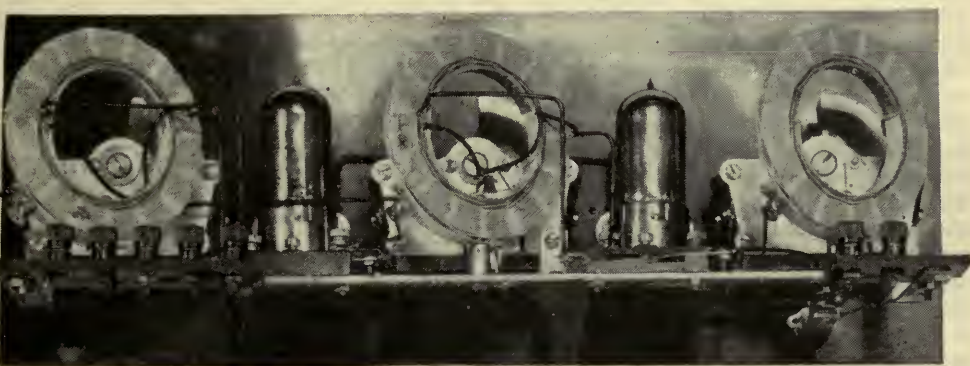
TO PASS the action of amplification from one tube to another, called cascading, some coupling means, which was previously explained, must be employed.

Several methods for coupling have been devised, such as untuned transformer-coupled, tuned impedance-coupled, and tuned transformer coupled. The names indicate the method employed to induce energy from the plate circuit of one tube to the grid of the next. Amplifiers employing tuned radio-frequency transformers have been generally accepted as the most satisfactory and they are embodied in the amplifier to be described here. The satisfactory operation of the set depends to a great extent upon the correct design of the radio-frequency coupling-unit.

The ratio of transformation is important. In some cases a 1 to 1 ratio is employed, but in the majority of cases the radio-frequency coupler has a step-up ratio of its own. For instance the primary or plate coil will be wound with ten turns of wire while the secondary coil will have sixty turns. This is a 6 to 1 ratio between secondary and primary respectively. The shape and size of the coils also have their good and bad effects on the successful operation of the receiver. The meaning of this ratio must not be misunderstood. Actually, when the number of turns on the primary nearly equal one half of the secondary, the voltage step-up is greatest but the neutralization becomes increasingly difficult with the increase in size of the primary winding.

When the amplifier employs coupling units of large physical dimensions there is danger of a feedback action between these several coupling units. This undesirable feedback is due to the magnetic fields of the coils becoming interlinked and interfering with each other. This danger is also present even when small coils are used, if they are placed too close together. The difficulty is overcome by turning the coils at such angles to each other that the coupling effects between the coils of the transformers themselves are minimized.

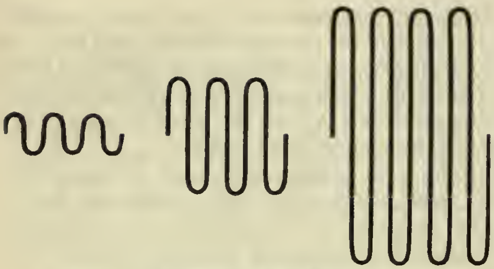
There are other methods of bringing this result about. In some amplifiers we find metal shielding which prevents feedback. Changing the angle of the coils is a simple



RADIO BROADCAST Photograph

BEHIND THE WORKS

A general view of the distribution of the parts. . The Bradleystats are situated behind the tube sockets



SHOWING GRAPHICALLY,
THE AMPLIFICATION IN SUCCESSIVE STAGES

FIG. 3

A graph showing the successive amplification in a cascade amplifier

effective method. It is necessary to wind the several transformers as nearly alike as possible so that when the secondaries are shunted by condensers of a like capacity the wavelength range will be the same for each stage. The dials will then read the same.

OSCILLATION; FEED-BACK NEUTRALIZATION

VACUUM tubes, when connected to the usual grid and plate coils may be made to generate an oscillation whose frequency depends largely upon the inductance of the grid coil and capacity of the condenser shunting it. See Fig. 4.

It is a well-known fact that, if a circuit embodying these characteristics were utilized, a miniature radio transmitter would result. This would be not only uncomfortable for the user himself because of the many-toned squeals set up, but an amplifier of this sort would also seriously affect neighboring receiving installations because it would act as a transmitter, producing squeals in every receiver within range. This property is usually termed the radiation characteristic of an amplifier.

Some means of balancing out these squeals must be provided. Lossers, compensators, traps, and reverse feed-back are sometimes employed but they are, as a rule, not as stable as the arrangement proposed here. A very fine form of this neutralizing system has been brought out by Hazeltine and Roberts. In their system, any tendency to oscillate is completely neutralized or balanced out by the neutralizing condenser and the proper placing of the coils, all exerting a force on the grid of the tube equal and opposite to that set up by the action of the inter-capacity coupling of the tube as well as the inter-coil coupling of the radio-frequency transformers. An explanation in detail of this theory by Mr. W. Van B. Roberts, appeared in the April, 1924, and was repeated in the January, 1925, RADIO BROADCAST.

Wiring also presents a problem to be solved by a careful and well planned procedure. Grid and plate leads should be as short as possible and should not be parallel to each other. There should not be any inductive loops in the filament circuit. In fact, the filament circuit should be finished first. Then the other connections to it may be made as short as possible.

Soldering is an important consideration and should not be overlooked. Too much solder is just as bad as too little. Keep your iron evenly hot and clean all the time. Don't use a great quantity of soldering paste and use a good grade of solder. While it seems strange that such mechanical considerations should enter into a discussion of the design of radio-frequency amplifiers, its worth may be realized when it is considered that a poor soldering job will completely offset the finest design and assembly, and render the amplifier practically inoperative.

HOW MANY STAGES?

NOW the number of stages of radio-frequency amplification that may be successfully employed is limited by the human element. Two stages of radio-frequency amplification have become accepted as the maximum number that may be advantageously operated. More than this usually lowers the operating efficiency of the receiver. Multi-stage radio-frequency amplifiers have made their appearance on the radio-market. These types are usually controlled by a gear arrangement actuating the several condensers, but due to electrical and mechanical difficulties, have not become very popular.

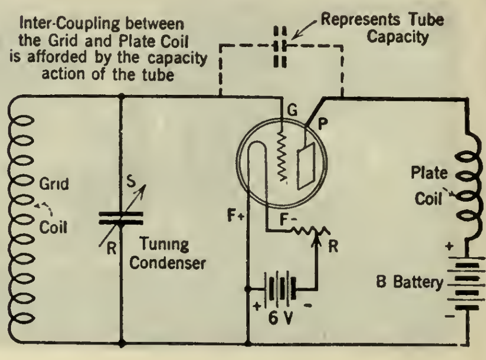


FIG. 4

A circuit capable of oscillating—thereby becoming a miniature transmitter when coupled to an antenna

RADIO-FREQUENCY TRANSFORMER DESIGN

THE style of winding of a radio-frequency coupler offers an interesting field for study. Spiderweb and diamond weave styles have lately come to the forefront of radio design because of the mechanical and electrical advantage they present and the ease with which they may be made and mounted. The same value of inductance can be provided in a concentrated spiderweb or diamond weave form which, if constructed as an ordinary single-layer coil would require a much larger space. Also, with these new inductances, the distributed capacity of the coil has been materially lowered which increases the overall efficiency of the unit. When the winding is concentrated, the magnetic field set up by the currents travelling through the coil is similarly concentrated and does not feed over into adjacent coil units.

Engineers have made electrostatic coupling a special study. Full reports of their findings are not yet available. However, the few bare facts such as separation of parts, concentration of coil winding, and simplicity of wiring serve to guide us toward correct constructional design. The circuit of the radio-frequency amplifier described here is shown in Fig. 5. This amplifier may be used with any type of detector and audio-frequency amplifier now available. In a future number of RADIO BROADCAST we shall describe a detector and amplifier unit especially designed for use with this radio-frequency amplifier.

This circuit consists of three tuned circuits. The output of the last circuit connects to the input of the detector tube to be used. The antenna and ground are connected to the primary of the first circuit.

As may be seen by the several photographs accompanying this article, all the parts are mounted upon the panel and a baseboard is eliminated. As far as possible, the ideas brought out in this discussion have been incorporated in the amplifier unit described here.

CONSTRUCTION OF THE UNIT

TO MAKE the amplifier in accordance with these instructions, it is well to procure the parts as listed. *Other parts of similar design and quality may be used with equally good results.* The use of UV-201-A or DV-2 tubes is recommended but others such as 1½ and 3 volt tubes may be satisfactorily employed.

The coils used were made up by the F. W. Sickles Co. of Springfield, Mass., from specifications supplied. For those who wish to wind their own, the coil data is included in the following pages.

THE PANEL

IN LOCATING the holes to be drilled in the panel, it is well to lay off the dimensions on the rear of the panel. Otherwise the

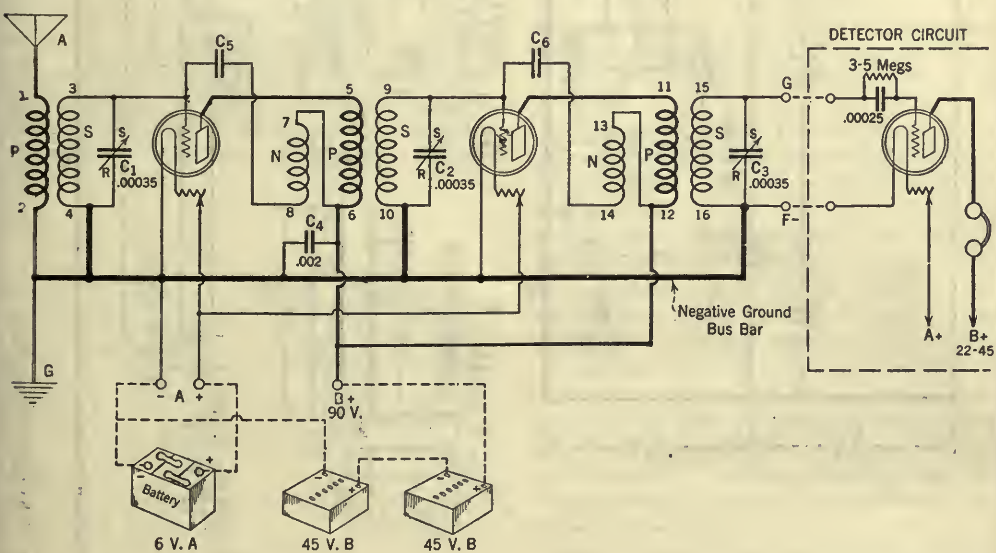


FIG. 5

The schematic circuit diagram of the amplifier whose construction is described. The heavy line indicates the brass bus bar strip connections

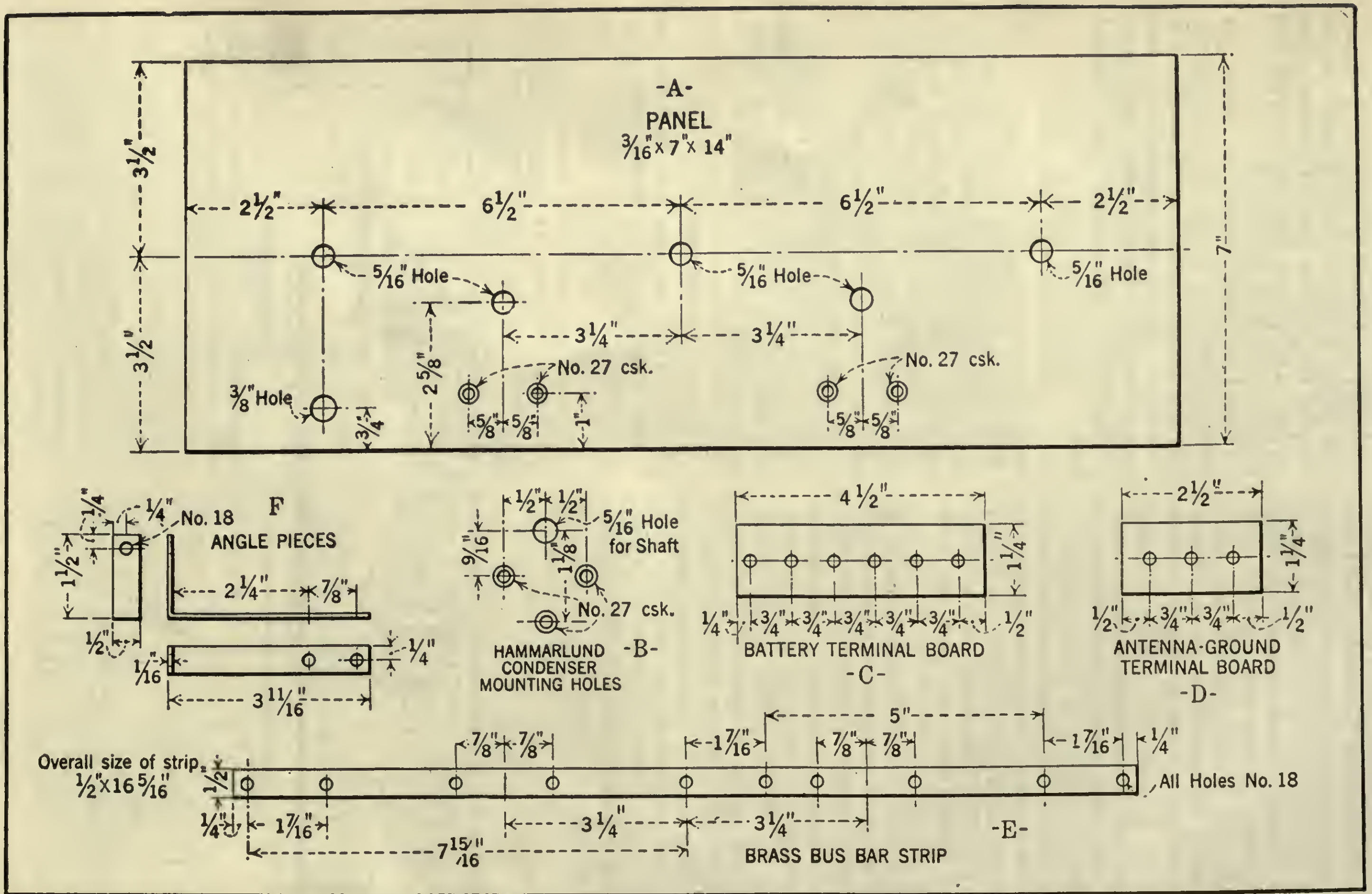


FIG. 6

A. The panel layout, front view. In actual practise it is better to transfer the dimensions to the back of the panel to prevent deep scriber lines. B shows the mounting holes for the condensers and C-D the binding post terminal strip layout. In E the details for drilling the brass bus bar are shown

scriber lines, if marked on the front, would be visible and unsightly unless removed by a graining process. Some builders will wish to provide a grained surface on the front of the panel. Graining may be accomplished by rubbing the panel along its length, with a straight motion, with No. 0 emery cloth. This is continued until all the glossy marks on the panel have been removed. The graining process usually takes place after all the holes are drilled. The panel is then polished with an oiled cloth.

RADIO BROADCAST Photograph

A SYMMETRICAL PANEL ARRANGEMENT

The jack in the lower left is for plugging-in a loop. Vernier dials may be substituted for those shown

In drilling the holes it is well to drill all of them first, with a No. 28 drill and then enlarge to the required size with the correct size drill. This procedure affords a more accurately drilled panel than if all the holes were directly drilled with the required size drills in the beginning. By referring to the panel layout in Fig. 6A it will be observed which holes are to be countersunk. This layout should be thoroughly understood before actual construction is begun.

In a similar manner of layout, the binding post strips and brass mounting bus-bar strip are prepared and drilled. See Fig. 6 C, D, –E, and F.

WINDING THE COILS

THE type of coil used here is termed the diamond weave. To wind these coils it is necessary to have a cylindrical wooden form (a rolling pin of the required size will do) $2\frac{3}{8}$ inches in diameter. Around the circumference of this cylinder, at approximately $\frac{1}{2}$ inch intervals are driven brass or wooden pins $\frac{3}{16}$ inch in diameter $1\frac{1}{4}$ inches long. The coil winding form is illustrated in the sketch Fig. A. No. 22 d.c.c. wire is used throughout the windings.

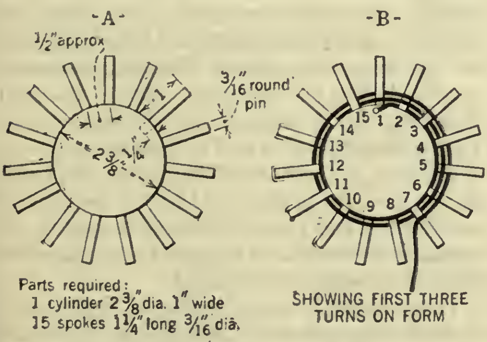


FIG. 7

A. is a coil form for winding the diamond weaves. B. How the weave is produced. Under two, then over two, is the rule

The antenna coupler has only a primary and secondary. The other two coil units have a

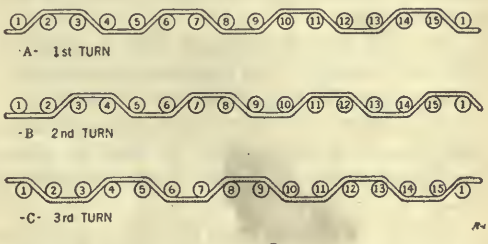


FIG. 8

Shows the first three turns in their relative positions to the spokes in producing a successive overlap resulting in the diamond weave coil

double-wound primary, constituting the N–P coils, and a secondary (S), as illustrated in Fig. 5.

The weave of the coil is produced as outlined in Figs. 7B and 8A–B–C. The first three turn positions are illustrated and will serve to indicate the progressive overlap of each additional layer of the winding. Success in this winding is all in the start. The beginning of the wire, allowing for a six inch lead, is fastened at the pin 1. From there it is brought diagonally to 2. From around the outside of 2 and 3 it diagonally crosses to 4. Here it again goes around the outside of 4, and 5, and so on. It will be observed from this that the winding style is continued over two and under two spokes.

Due to the odd number of spokes, the successive layers progress or stagger themselves. This permits a winding which makes the position of each layer wound different from

adjacent layers. So the diamond weave is produced.

For the second and third radio-frequency couplers, the primaries must be double-wound to provide the neutralizing winding which is connected to the grid of the tube through the neutralizing condenser. In winding the double primary it is well to have two spools of wire, one preferably colored so as to facilitate identity of connections.

Six and one half turns of the pair of wires are wound for the primaries of the second and third couplers. This ratio was selected after tests were conducted where 12 and 18 turn primaries were employed.

The antenna primary consists of a single wire wound for six and a half turns.

After the primaries are wound, the secondaries are wound directly over them for forty-five turns in the same fashion and in the same direction as the primary. The inside lead or beginning of the secondary is started several spokes away from the end of the primary so that the leads are not too close together in the finished coil.

The coil may be painted with a solution as a binder which has been prepared by dissolving celluloid in acetone, or other "dope" of this nature. The best coils are made without dope and their turns are held in place by lacing made of ordinary grocer's white cord.

To remove the coil from the form, withdraw all the spokes and then slide the coil off, taking care to prevent it from coming loose. Fig. 9 shows how to insert the mounting screw so that the coil may be fastened to the brass bus bar running the entire length of the receiver. The outside turn of the secondary connects to this screw. The brass bus bar constitutes

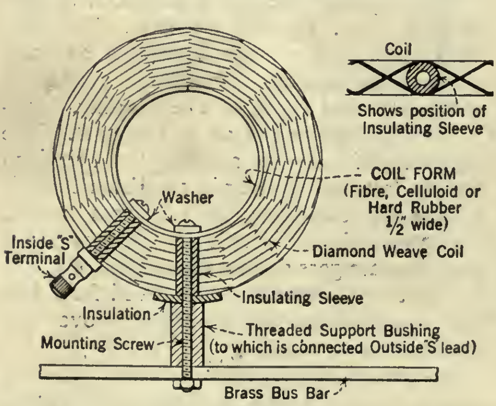
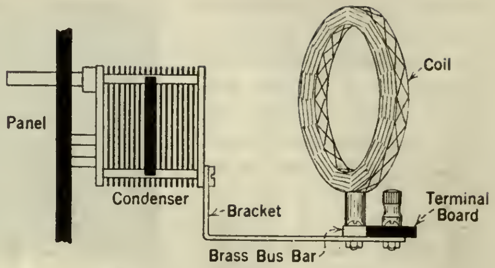


FIG. 9

How the coil is mounted on the brass bus bar strip



METHOD OF ASSEMBLY OF CONDENSER, ANGLE BRACKET, COIL AND TERMINAL BOARD

FIG. 10

All the parts are sustained by means of the panel and angle brackets

the negative or grounded line of the entire circuit.

As may be seen from this sketch, the $\frac{6}{32}$ mounting screw is securely fastened to the coil by means of washers and nuts. If it is obtainable, a piece of bakelite or fibre tubing $\frac{3}{16}$ inch in diameter may be slipped over the mounting screw to insulate it from the coil winding. The narrow strip of hard rubber or celluloid used as a coil form and inserted after it is wound is also fastened underneath the head of the screw and washer.

The coil support may be a larger-diametered piece of tubing or a brass rod may be turned down if the machinery is available. But as little metal as possible should be used in the direct field of the coils.

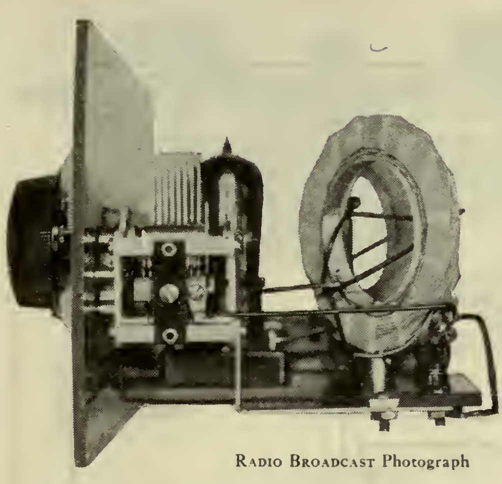
ASSEMBLY

WITH the panel drilled, the coils wound, and all the other material on hand, the job of assembly may now be started.

First the sockets, then the rheostats and finally the condensers are mounted on the panel. It is well to state here that the assembly directions as outlined only hold good for the material as listed. When other parts are used, the builder must employ his own ingenuity in producing an arrangement as nearly like that described as possible.

Looking at the back of the panel, the lower right screw of the right and center condensers holding the end plate of the condensers to its frame is removed. Also the lower screw of the left condenser is removed.

Brass angle brackets $3\frac{11}{16}$ x $1\frac{1}{2}$ inches x $\frac{1}{2}$ inch are fastened, as shown in Fig. 10, to the condensers at the places where these screws have just been removed, by replacing the screws securing the brackets at the same time. It is absolutely essential that these screws be



Radio Broadcast Photograph

A VIEW OF THE ANGLE BRACKET FROM THE RIGHT SIDE

exceptionally tight, but not tight enough to turn off the heads, so that a positive electrical connection between the condenser and plate, angle bracket, and bus-bar strip is assured.

Fig. 10 also shows how the binding post terminal strip is mounted on the bracket. Connections to the binding posts are made on the under side, and the wires are soldered to lugs fastened to the posts.

Fig. 13 shows the angle at which the coils are placed when mounted upon the bus bar strip.

WIRING

DUE to the placement of the parts, the grid and plate leads are comparatively short and well separated. In fact the only long leads in the circuit are the filament supply connections.

All connections should be soldered. Lugs may be used at socket and condenser terminals to facilitate the soldering job and this also permits the terminal nuts to be tightly fastened down on the lugs before the soldering is begun. Suitable wrenches for this work are now on the market. The wiring plan is shown in Fig. 11. The schematic circuit diagram is Fig. 5.

The jack shown in the lower left hand corner of the panel photograph is used for plugging-in the loop to the first tube circuit. This jack performs the function of automatically disconnecting the first secondary coil from the tuning condenser and replacing it with the loop. See Fig. 14.

The inside lead to this secondary connects to the blade of the jack marked No. 2. The outside lead connects to the brass bus bar negative line through the metal screw and support bushing. The third and fourth blades of the jack also connect to the negative bus bar. Blade No. 1 connects to the stator plates of the condenser. These points are made clear in Fig. 14.

The connections to the coils are as follows:

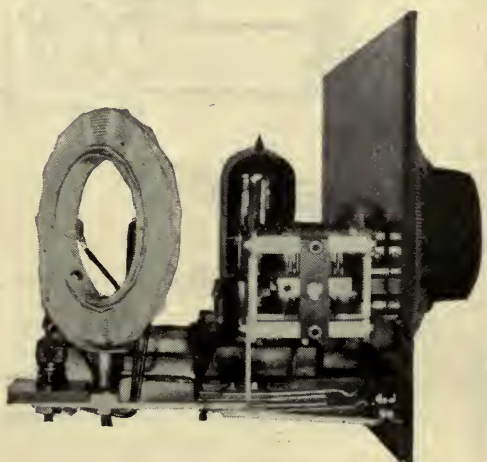
The antenna connects to the inside of the primary, the outside to the ground. The inside of the secondaries connect to their respective grid socket terminals, the outside leads being connected to the negative side of the filament line. The mounting screw is utilized and another screw terminal provided as shown in Fig. 9 for the secondary leads. The primary leads merely project out of the coil.

For the double-wound primaries, the inside lead of one of the pair of wires connects to the plate of the preceding tube. The outside end of the other coil connects to the grid through the neutralizing condenser. The remaining two leads are connected together and are brought to the positive B battery terminal.

A .002 mfd. fixed condenser is connected from the B terminal to the minus A terminal. A detector circuit (to which, of course, may be added several stages of audio-frequency amplification) is connected to the r. f. amplifier as shown in Fig. 5. for test purposes.

OPERATING THE AMPLIFIER

ASSUMING that UV-201-A's are used throughout (although any standard type of tube may be substituted) the 6 volt filament



Radio Broadcast Photograph

LEFT SIDE OF THE AMPLIFIER

The bracket supporting the bus bar, coil, and binding post terminal board is clearly shown, and the jack mounting as well

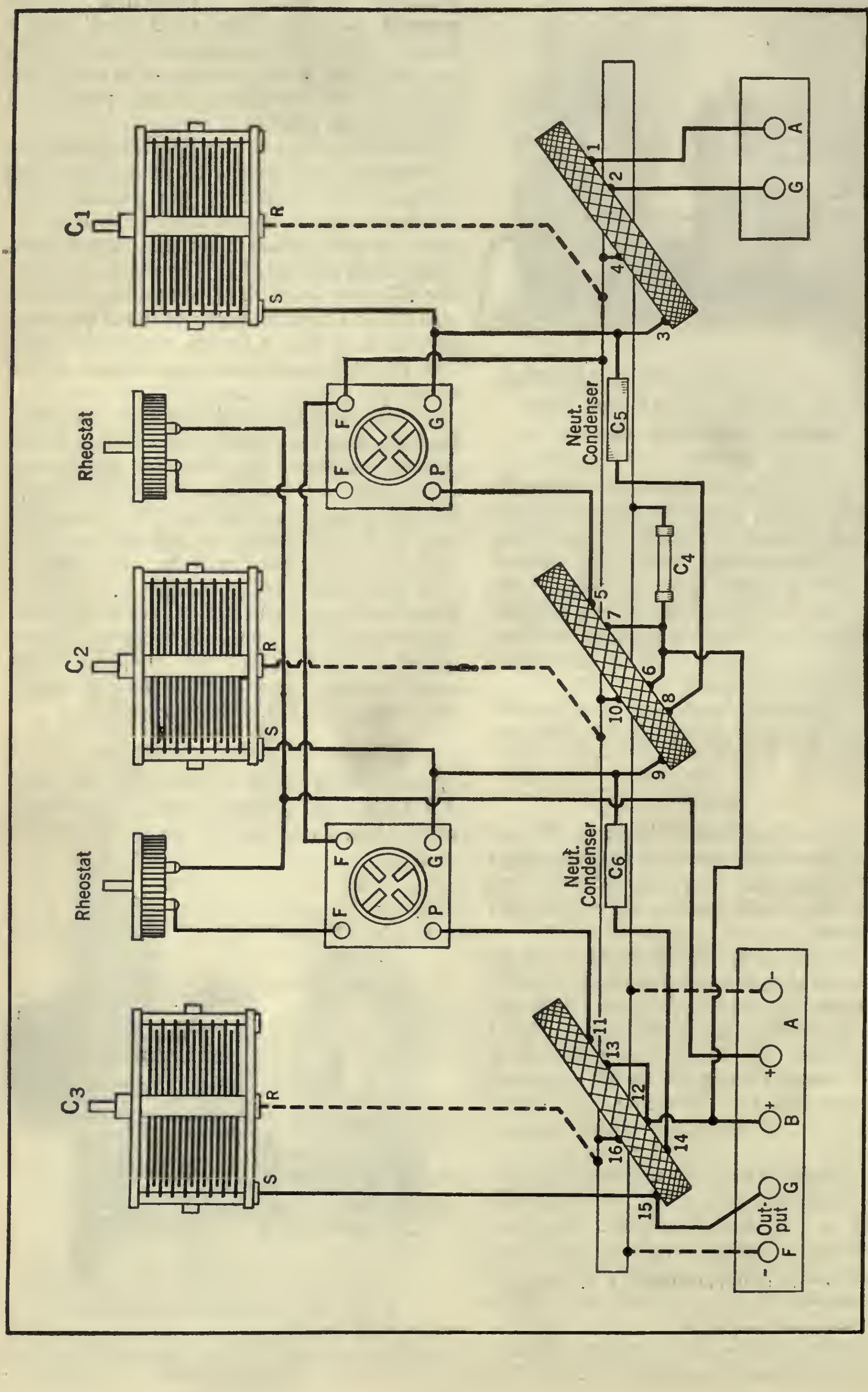
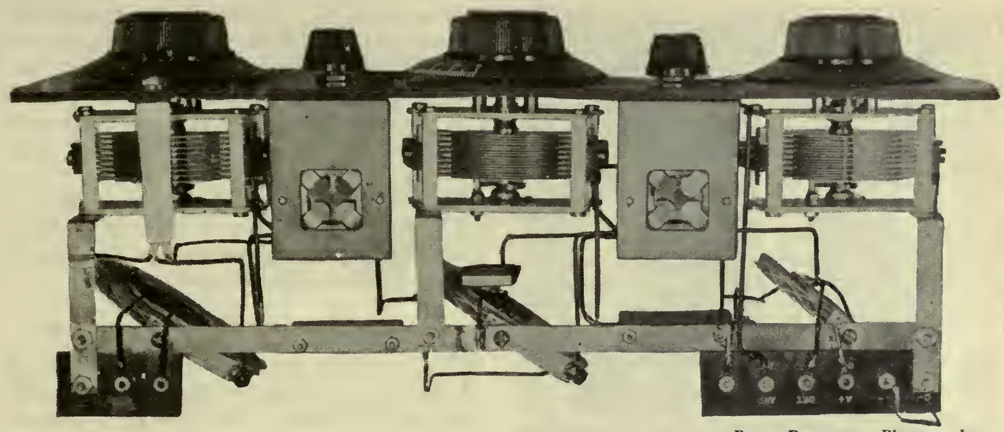


FIG. 11

An actual wiring layout of the amplifier. The various coil terminals are numbered and correspond to those shown in Fig. 5



RADIO BROADCAST Photograph

LOOKING UP FROM UNDER

The function of the bus bar as part of the circuit and as a supporting member is clear. The sockets are of the panel mounting type

battery is connected to the battery posts on the terminal board at the left of the amplifier (looking at the rear). From right to left, these posts are designated as follows:—negative filament, positive filament, positive B battery, grid output, negative filament output.

The posts on the right terminal strip are:—antenna and ground, from right to left. The B battery post is connected to the 90 volt terminal of the B battery. The other connections are made as shown in Fig. 5.

With the aid of the wavelength curve shown in Fig. 12, the approximate position of the dials may be ascertained for a desired wavelength setting. Due to differences in winding the coils and wiring, this curve will not be accurate for every amplifier of this type which may be constructed.

It will be observed that the antenna coupler condenser will tune rather broadly in comparison to the other two.

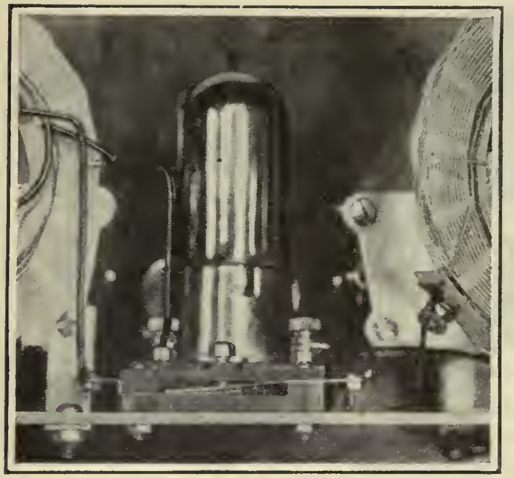
The method of tuning the amplifier would be to set the antenna condenser dial at the desired setting, referring to the curve and then slowly rotate the other two simultaneously through a small arc at approximately the same setting. When the sharpest point has been obtained, retune the antenna condenser dial for a final setting.

LIST OF PARTS USED

1	Panel 7 x 14 x $\frac{3}{16}$ inches	@ $1.00	$ 1.00
3	Hammarlund Variable Condensers .00037 mfd.	@ 4.75	14.25
2	Federal Panel Mounting Sockets	@ 1.20	2.40
2	Bradleystats	@ 1.85	3.70
3	Sickles Coil units	——	——
2	X–L Vario-densers	@ 1.00	2.00
3	Na-ald Super De-Luxe Dials	@ 1.00	3.00
	Brass strip		.50
	Mounting screws—wire, etc.		.50
1	Double-circuit Carter Jack		1.00
			$28.35

When the coils are home-made the supplies necessary for their winding are as follows:—

$\frac{1}{2}$ lb. No. 22 d.c.c. wire
Bakelite or metal bushing supports
Washers
Insulation strip, fibre, celluloid, etc.
Screws and nuts



RADIO BROADCAST Photograph

A DETAILED VIEW OF THE NEUTRALIZER

Part of this condenser is cut away. The turning of the screw, top center, varies the capacity

NEUTRALIZING THE AMPLIFIER

ON THE lower wavelengths it will be observed that the amplifier will go into oscillation more easily than on the higher wavelengths.

Now, by turning the adjusting screw of the neutralizing condenser, up and down, a point may be reached where the self oscillation is entirely eliminated or perhaps only feebly present. This oscillation is recognized in the form of a squeal whose pitch varies. The detailed method of neutralization was fully described in "Notes on the Robert Circuit," in the January, 1925, RADIO BROADCAST.

It is well to apply the neutralization process at several wavelengths, noting the position of the tubing for each change, so that an average may be struck. If the amplifier works properly, no great difference in the several neutralizer settings will be noted.

Since this circuit; is not reflected it is quite satisfactory to employ the standard neutrodyne method of neutralization. Briefly explained, that is as follows: A station is tuned-in, preferably a distant one, so that the signal is not as loud as a local. Then the first tube is removed from the socket, and one filament prong is covered with a slip of paper or spaghetti tubing, so as to insulate it when replaced in the socket. Now after inserting in the socket (the filament will not light) the station previously tuned-in may be heard faintly. Carefully retune for maximum signal strength, which will not be as loud as when the tube was lighted. Then adjust the neutralizing condenser until the signal almost, or perhaps actually disappears. This tube is then completely neutralized and the same process may be applied to the next tube. As each tube is neutralized, the filament prong insulation is removed.

With the condensers and coils used, as described, the amplifier will cover a wavelength range varying from 230 to 600 meters for the entire broadcast band.

WHAT TO EXPECT FROM THE AMPLIFIER

THE author does not attempt to set a distance limit on reception of a set using this amplifier when connected to a detector circuit. The radio public has educated itself to the point where it takes with a grain of salt the highly imaginative claims of sometimes over-enthusiastic set designers about the distance range of their receivers.

It is not our desire to put a limit on the reception qualities of this amplifier. Rather let us say that it will equal any two stage radio-frequency amplifier we have ever tested

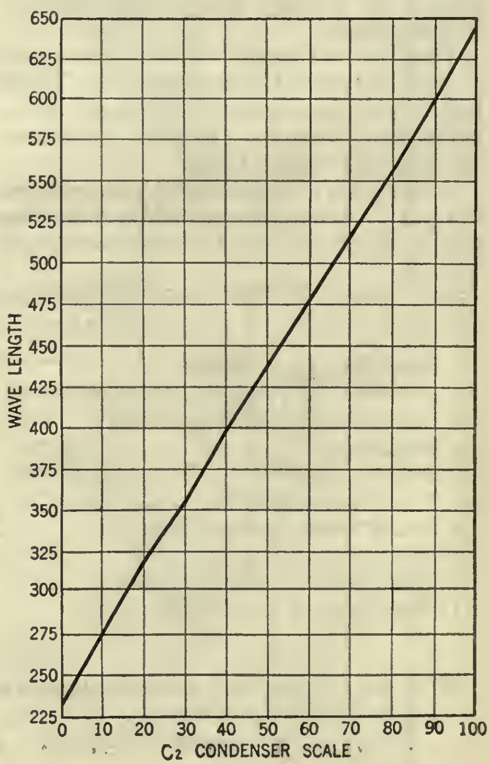


FIG. 12

A wavelength chart which may be used as an aid in locating stations

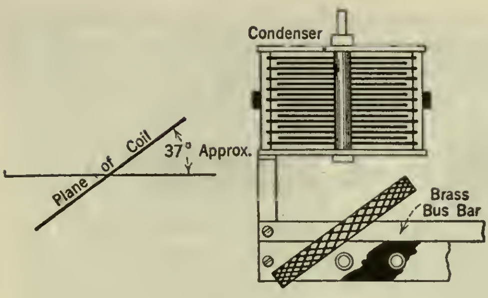


FIG. 13
To obtain complete neutralization, the coils should be turned at an angle to the bus bar as shown here. The value is approximate. Actual test will determine the correct placement

—and we've surely tested more than a few.

This radio frequency amplifier is especially adaptable for use with a loop.

In a future article the construction of a detector amplifier unit will be described which, while it may be used with any tuner, is especially intended for use with the radio-frequency amplifier described here.

General Additional Notes

THE use of a loop with this amplifier will naturally reduce the strength of received signals and therefore not a great deal of distance work will be accomplished when the loop is used.

However, for sharpness of tuning, and quality of reception, the results when a frame antenna is used are difficult to equal where local stations are being received. Loop reception on locals is desirable where tone quality and clarity are prime factors. The placement of the loop near the antenna-ground wires (which may be connected .together) loosely couple it to the antenna circuit which increases the volume but may effect the quality of reception because this connection will cause some static to be received when any is receivable.

The tuning of the first condenser when a loop is used will depend largely upon the number of turns of wire wound on the loop.

For all practical purposes, a standard pancake loop 30 inches square, wound with 16 turns of wire spaced $\frac{3}{8}$ of an inch apart will suffice covering the entire broadcast wavelength band.

If variable plate neutralizing condensers are used, some other means for mounting them on the brass bus bar strip must be arranged. It is not advisable to mount them on the panel unless such an arrangement permits of the use of very short leads. The adjustment of this neutralizer is very rarely changed, so that for all practical purposes, the back-of-panel mounting will prove quite satisfactory.

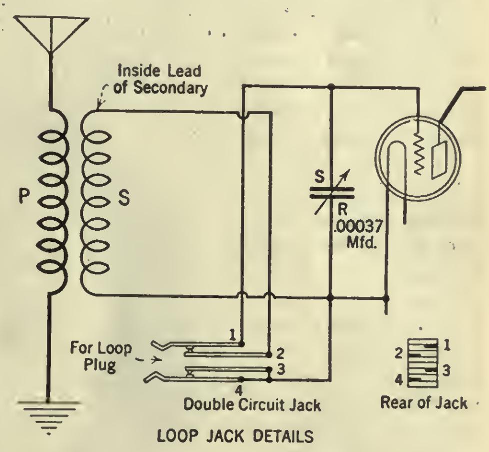


FIG. 14
When a jack is incorporated for the use of a loop, the circuit must be altered so that the antenna coupler may be automatically thrown in the circuit when the loop is not being used

The Listeners' Point of View

Conducted By Jennie Irene Mix

Good National Radio Programs Prove "What the Public Wants"

THE linking of a sufficient number of stations to carry to uncounted listeners the WEAF programs of outstanding musical quality will do more to bring about a reform in the general character of all radio music than any other attempt that has yet been made with such an end in view. Not that the powers that rule WEAF had this in mind when establishing this wide connection through the country. Quite the contrary. With those officials it is wholly a matter of business, as all who are familiar with the firms who are putting these programs on the air through WEAF well know. But one could scarcely ask the American Telephone and Telegraph Company to give this well-nigh priceless opportunity to the public for nothing. So, as the intricate question "Who is to Pay for Broadcasting?" apparently remains as far from being answered as ever, we may well be thankful that we have this present development which makes possible the hearing of real artists at stated times, instead of, as before, being almost always nationally swamped by mediocrity or worse.

JOSEPH KNECHT

Without whom the Waldorf Astoria would almost have to go out of business, or so it seems. He has long been conductor of this hotel's Concert Orchestra. Their Sunday evening programs, broadcast by WJZ, are prime favorites with radio listeners

Lovers of good music now glory in the opportunity to hear it through their receiving sets on those nights when such music is specially featured. And we are confident that hundreds of thousands who have until now always referred to such people as "highbrows" or "poseurs," are going to go over to these very ranks when they find through experience that love of good music is no more a pose than is the preference of living in a neighborhood where the surroundings are beautiful to the eye rather than in one where ash and garbage cans predominate.

It might seem, after all, as if the best way to cure the public of a desire for the undesirable is to surfeit it with the undesirable. After having heard announced, "The orchestra will now play, 'Dirty Face,'" about one hundred thousand times, they may welcome hearing that the Victor Talking Machine Company orchestra will play the "Ballet Music from 'Faust'." Especially will they welcome the announcement after they hear this music a sufficient number of times to become familiar with it. You see, we are taking it for granted that

ANNA PINTO

The youthful harpist who has been heard frequently during the season from WJZ, is now "off the air" until fall, having gone on a well-deserved vacation

those who have been reveling in "Dirty Face" over the radio lack acquaintance with this ballet music which is probably as well known as any music of its kind ever written.

The much-discussed question of having a few very high-powered stations in this country that would ultimately control all the broadcasting has met with violent opposition from the hundreds of stations conducted for the purpose of advertising the products of the business firms operating them. The majority of these stations are far below any commendable standard so far as their programs and the manner in which they are presented are concerned. Will this new development in radio, which is bringing the best in radio music to far distant points, in time put these stations out of business? There would be nothing lost and a good deal gained for the public were this to come to pass.

PROFESSOR MARSHALL S. BROWN

Dean of the faculties of New York University, who has delivered interesting weekly lectures on American history from station WJZ, New York

Does it not look as if this linking of stations is but another way of having the broadcasting within the power of the few? Be this as it may, developments along the right line are coming so rapidly that all who have deplored the quality of radio programs in this country are beginning to grow optimistic. Whether the methods used to bring about this change will be permanent, no one can say. But of one thing we may be absolutely assured. Radio music having had this upward trend, can never again sink to the low level that has so widely obtained.

Of great interest are the statistics given by John A. Holman, broadcasting manager of the American Telephone and Telegraph Company relative to his opinions of the change in the musical taste of radio listeners during the past two years. In January, 1923, approximately seventy-five per cent. of radio fans favored jazz. In the same month of 1924 this percentage fell to thirty five and in January of this year to five per cent. These figures tell their own story.

Among the fine programs regularly featured through WEAF are those given by the Atwater Kent Company. Have you noticed that the singers of the quartet heard in these programs are never announced by name? That should be qualified by saying that we have never heard them so announced. "The tenor of the Atwater Kent Quartet will now be heard in the solo, "On-away, Awake, Beloved!" And when you hear him sing you know that he is not an amateur looking for publicity through the microphone; indeed if he were, he would insist on having his name announced, "before and after." We are quite willing to hazard the guess that this quartet is made up of paid professionals—and admirable ones at that—who do not want their names sent out as "radio artists," a position that can be understood considering the present chaotic conditions prevailing in broadcasting. If this guess is a wrong one, we stand ready to be corrected.

Are not the phonograph companies, as long as they broadcast programs made up from titles almost entirely taken from the titles of records made by each artist presented, in danger of a repetition that will be tiresome? Here is a tip for the Victor authorities. Have all your baritones avoid "La Paloma" for a time!

Great Artists Are Coming to Radio

UNDER no circumstances will I ever permit an artist under my management to be heard by radio. Were such a thing to happen without my consent, I would consider it ground for cancellation of contract and take immediate steps to bring that about."

Many managers of musical artists have said this to the present writer. And one and all are now permitting, evidently gladly, the most famous people under their management to be heard over the microphone. Nor are these hearings confined to the programs of the phonograph companies, but go so far as to include appearances at public concerts. We do not know that, to date, any complete public recital by any artist has been broadcast, but where the program is a mixed one, various artists appearing, a portion at least of each artist's contribution to the whole is given to the radio public. It all but goes to prove that we must either keep up with the procession or drop out of it altogether.

DOES hearing the phonograph programs stimulate your desire to take advantage of the opportunity when it offers of hearing and *seeing* these same artists in concert? We are of the belief that, with the majority of people, hearing an artist in a few numbers would arouse the desire to hear him in an entire concert if possible.

What Happened at WTAM

IN THE March number of this magazine, the statement was made in "The Listeners' Point of View" that on Christmas Eve, "Silent Night, Holy Night," was jazzed from station WTAM, Cleveland. The statement carried the explanation that the present writer did not hear this sacrilege and hotly denied it when first given the information, but that this information came from a sufficient number of sources to seem to prove it true. It appeared at the time all the more inexcusable considering the standard maintained by WTAM which is conducted by the Willard Storage Battery Company.

It is with pleasure, therefore, that we

ROSELINE GREENE

Leading woman of the WGY Players, who is but eighteen years old, and a junior in the New York State College for Teachers, where she is taking the classical course. Her entire professional dramatic experience has been gained under Edward H. Smith, the director of the WGY Players

publish a denial of this statement received in a letter from Mr. S. E. Baldwin, in charge of broadcasting at WTAM:

So far as we know, the only time this particular piece of music has been sung or played over station WTAM was on the night of December 24, 1924—Christmas Eve. On that particular program it was played or sung some five times, being first sung by the Cleveland Music School Settlement, under the leadership of Alice Shaw Duggan.

The second time it was sung by the Old Stone Church Quartet, composed of Mrs. Robert J. Kelly, Alice Shaw Duggan, Harold Branch, and Fred S. True. This quartet is probably the best known church quartet in the city of Cleveland.

It was then sung by Miss Marie Similink, one of the leading contraltos of Cleveland. Later in the evening it was again sung by Doris Stadden Kaser, and at midnight played by trumpeters of the Cleveland Concert Band in conjunction with chimes from the Old Stone Church.

The writer was either present or listened by radio to the entire concert; he is perfectly familiar with the music, and to the best of his knowledge, nothing of the kind of which you accuse us occurred on the night of December 24th.

Isn't it rather unjust to publish statements of this kind without first taking them up with the supposed offender? There is a possibility that sometime you may be wrong.

Frankly acknowledged. Probably a number of people heard more than one station at once at that hour, the leading fault of radio at present. At any rate, there is a moral in this. Never say it was so unless you heard it yourself.

ABE MARTIN says: "So far I ain't noticed that any romances hev cum from th' publishing of radio photographs."

MAGDELINE BRARD

A very artistic French pianist, who, although scarcely out of her 'teens, commands the admiration of connoisseurs in both this and her native country. She was recently heard through station WEAF

Shall Broadcast Music Be Explained?

IT WOULD be well if all the musical explanations now preceding the numbers presented on the Victor and Atwater Kent programs were completely done away with until they can be presented as they should. Some of us even go so far as to believe they should never be attempted under any circumstances. As matters now stand, they are compiled evidently from the studio dictionary by someone who knows nothing of the subject. They are put into type and then read by the announcer.

When Toti Del Monte sang "Caro Nome" from "Rigoletto," the attempt to explain what the song meant was wholly futile. For that matter, you can go to any of these early Verdi operas and never completely know what the story is about. How, then, can Gilda's infatuation for the dissolute Duke be explained?

Then there was De Luca's singing of "Largo al factotum" from Rossini's "Barber of Seville." We defy anyone who has been to see this opera one hundred times to tell the plot offhand. There was no attempt to tell the plot when De Luca gave his superlative rendition of this number, but there were some jumbled comments about his fame in the rôle of "Rigoletto," and then something about the rôle of the barber, "Figaro," in the Rossini opera.

If something must have been said, why not let it go with saying that "Largo al factotum" is one of the most famous comic songs in all operatic literature, and that De Luca is unexcelled among living baritones in its interpretation?

LOLA SUMMERS
Ingenue of the WGY Players. She has been associated with this radio dramatic company since their first production

How Classical Music Should Be Played

WE ARE much interested in learning the outcome of the suit for $10,000 damages filed by Francis E. Woodward, a music teacher of Spokane, against the leader of an orchestra in that city, the allegation being that the rendition by the orchestra of the classical compositions of the old masters is such that, "the public has received a perverted idea of classical music, insofar that children may no longer desire a musical education."

The jazzing of the classics is the greatest outrage perpetrated by jazz orchestras. Mr. Woodward assuredly had the courage of his convictions in entering this suit. A pity he could not have filed it against the city instead of an individual. Where the classics are seldom heard in their original form in public performance, the influence of these mutilations would be much more far-reaching than in Chicago or New York, let us say. Would that Mr. Woodward might win ten times ten thousand dollars!

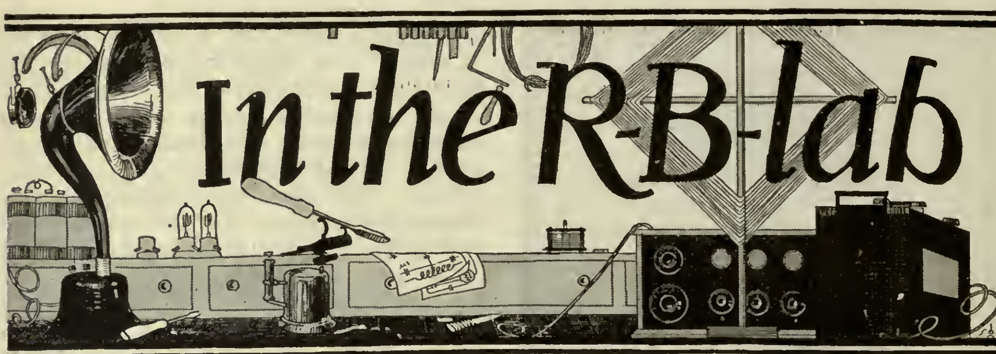
The Fame of Georges Bizet

IF GEORGES BIZET, composer of "Carmen," and of the "L'Arlésienne Suite" so frequently heard over the radio from the better class stations could know that his name, through the means of broadcasting, is now familiar to practically the entire American public, well, imagination fails to measure his astonishment. After meeting with little but failure throughout his short life, he died at the age of thirty-nine, a few days after his "Carmen", now judged by many as the one perfect opera ever written, was first produced. Three years before this he had been commissioned to write incidental music to Alphonse Daudet's three-act play, "L'Arlésienne." The play was withdrawn after fifteen performances. Of the twenty-seven musical numbers written for this drama, Bizet chose various ones and from them made a suite for concert use, and this was successful. The music, as all who have heard it know, is exquisite. It has all the elegance and finesse of the French school, and in the "Adagietto" carries the theme of sadness with such art that it becomes beauty rather than sorrow.

But Bizet did not confine himself to the French school by any means when he wrote "Carmen." Here is a Spanish story translated by a Frenchman into Spanish atmosphere with music that, while although it is not of Spanish origin, sounds as if it were. But it speaks of admiration of Wagner, even more.

June 3, 1925, will mark the fiftieth anniversary of Bizet's death. After all, that is not so very long to have become established as world famous, when, in dying, success, to say nothing of fame, seemed a myth.

JOHN A. HOLMAN
Director of Broadcasting for the American Telephone and Telegraph Company. He has made a careful study of the preferences of radio listeners, judging from the letters written to the various stations controlled by his company, and recently announced that public preference was swinging from jazz to classical music



How to Record Radio Signals

THERE are many occasions when it is desirable to make records of wireless reception. Figs. 1, 2, and 3 illustrate a system of recording that is comparatively simple and yet quite effective. The apparatus described was installed as a check on fading phenomena during the total eclipse of the sun on January 24th, 1925.

The apparatus consists of three primary parts, the tuner — which may be any convenient set — the amplifier, and the recording dictaphones. Two stages of amplification are sufficient, although three steps of resistance-coupled intensification with volume control were used in this laboratory. It is advisable to have some volume regulation in order to lower the maximum intensity below the blasting point of the recording diaphragms.

Standard office dictaphones were prepared by affixing telephone receivers to the throats of the speaking tubes. The soft rubber fixtures intended for adapting head sets to horns, are convenient for the purpose. Two dictaphones are not required but were employed in the RADIO BROADCAST tests to insure an unbroken record.

The machines should be located at least five feet from the receiver and more if convenient, to eliminate motor induction. Grounding the frames of the machines will also reduce interference from this source.

It is generally desirable to monitor recording on a loud speaker. This is most easily accomplished by connecting the telephone receivers (clamped to the recording instruments) in series with the loud speaker. A shunt variable resistance, 200 to 5000 ohms, across the phones, provides the recommended volume adjustment, without greatly affecting the loud speaker. If more convenient, any other satisfactory form of speaker unit may be substituted for the phones.

In recording fading, it is advisable to keep the receiver oscillating and record the beat note or squeal of the distant stations. In addition to the greater intensity and sensitivity of this arrangement, signal variations will be much more noticeable due to the fact that the sound will vary approximately as the square of the signal variations.

> *In the R. B. Lab. This Month*
>
> *A Complete Article—Radio Recording with a variety of applications, such as tracing oscillating receiver interference, learning the radio code, and others.*
>
> *Shooting Trouble—How we go about it. This article is the first of a series that will help the reader to solve difficulties in his receiver systematically and swiftly.*
>
> *Notes on Wiring Your Own Lab.*

OTHER USES

ASIDE from the recording of fading and swinging, this apparatus may be put to many other interesting and useful purposes.

It will immediately suggest itself for recording programs of special or historical interest, such as the inaugural address of the President of the United States. Reception is affected in the manner described, except, of course, that no beat note is produced.

LEARNING CODE

DICTAPHONES have been used for some time in the reception of high speed (80 to 100 words per minute) radio telegraph code signals. For transcription, the machine is

slowed down considerably, and the messages typed off at perhaps twenty words a minute. Speed reduction presents an excellent system for learning the code — an acquisition which many broadcast enthusiasts are attempting. It is merely necessary to speed the machine slightly and record any six hundred meter commercial station, or two hundred meter amateur station, and copy the sending of the operator at the desired reduction. The machine is tireless and will give you any number of repetitions.

TRACING CODE INTERFERENCE

ALL types of interference can be logged on the machines and later identified by an expert, as amateur interference or commercial code, arc-lights, leaky pole transformers, etc. *It is only when the type of interference has been determined* that it is possible for the radio inspector to take steps to eliminate it.

Systematic logging of all kinds of interference for later identification by an expert radio telegraph code operator would go far toward clearing up the air.

An identified "blooper" made to listen to his own mush, recorded on a neighboring receiver, may be thoroughly impressed with the iniquity of his action.

REPRODUCING

THERE are two convenient ways of reproducing the radio records. The first, and perhaps more satisfactory method, is to employ the standard dictaphone transcribing machine, listening in the customary manner through the rubber tubing. The second, and more spectacular system, is to reproduce electrically, amplifying the sound and outputting it to a loud speaker. This method is illustrated in Figs. 2 and 3.

The arrangement as suggested in the diagram consists of three parts, the microphone for picking up the sound, the amplifier, and the talker. This apparatus may readily be a simple re-arrangement of the equipment employed for recording. The microphone (of the magnetic type) is conveniently the telephone receiver or loud speaker unit clamped to the throat of the dictaphone adjusted for reproducing, but connected to the input instead of the output of the amplifier. The loud speaker

FIG. 1

Making fading records in The R. B. Lab. Beat-note fluctuations are monitored on the loud speaker and permanently recorded on the dictaphones

remains in the plate circuit of the last tube.

When recording and then reproducing in this fashion, it is most important that the amplifier, which is really used twice, be free from audible distortion. With the interposition of the several mediums, it is inevitable that quality will be lost, and every effort must be made to reproduce faithfully. Unless the experimenter is very sure of the results produced by his amplifier, resistance coupling is recommended. In the photographs, a three-stage resistance-coupled amplifier was employed for recording, and a two-stage transformer-coupled amplifier for reproducing.

The reproducing system can be readily applied to any phonograph arrangement where great volume or electrical transmission is desired. It is only necessary to place the microphone where it will intercept the sound waves at a point of fair concentration. A magnetic microphone of the type described is preferable to the ordinary carbon grain variety.

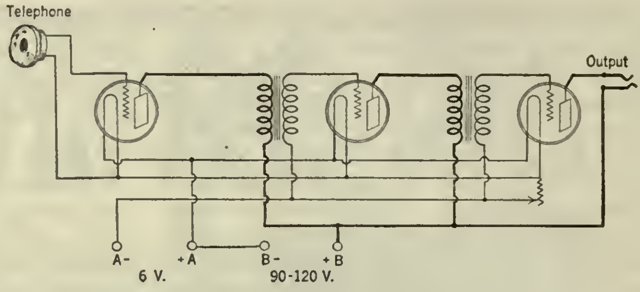


FIG. 3

The circuit diagram for the amplified reproduction of audio records. This system may be employed for the amplification and transmission of phonograph music

SHOOTING TROUBLE

EVERY laboratory, and every radio experimenter for that matter, must be prepared for the innumerable difficulties that beset the way of radio experiment. This laboratory has its full share of them; in fact it is part of its business. Shooting trouble may be simplified and thereby made more swift and efficient, by following a certain logical procedure. A doctor does not treat his patients in a haphazard manner. He does not tap them on the chest when they have a tooth-

FIG. 2

The amplifying arrangement for reproducing the records on the loud speaker. The telephone receivers or loud speakers employed for recording may be used as pick-up microphones in reproducing

ache, but rather he observes the symptoms and through a sequence of thought and experiment establishes just what and where the trouble is. Likewise in radio a few consistent observations, even by the most unexpert member of the family, will often solve the difficulty without calling in an expert.

There are three types of radio difficulties:

Absolute Inoperation
Poor Operation
Noises

These are general headings and they cover a multitude of the conventional radio sins. In this article we shall begin to treat the first group, not because it is the most prevalent (which is doubtful) but because its treatment is the more definite and simple.

THE SET WON'T WORK

PERHAPS the receiver is turned on in the usual manner but nothing happens. The receivers or loud speaker is dead, and the twisting of dials futile. The first thing to be done is to locate the trouble. The second task —to be treated next month — is to apply the remedy associated with that particular trouble.

Test No. 1—Turn off the bulbs, listening for a click in the phones or speaker. No click indicates a break somewhere in some battery circuit. When there is no click, we proceed to

Test No. 2—Inspect the bulbs. If they light, the filament circuit is O. K. A very dim, partial light (which however, should give a faint click in Test No. 1) suggests a low A battery. One or more bulbs may be "blown". If the bulbs do not light we try

Test No. 3—Make a momentary "short" of the binding posts on the set generally marked A-plus and A-minus, with a pair of scissors or any other metal object that is convenient. A spark indicates trouble in the set itself—filament wiring, burnt-out rheostats, loose socket prongs, filament control jack, or an inoperative switch. No spark shows that the trouble is on the battery side — in the leads to the battery, in the battery terminals, or a dead battery.

If Test No. 2 finds the bulbs normally

FIG. 4

"There is no spark, Harry, You 'd better take a look at those battery leads". There are many simple tests that almost any one can make which will show up the more common radio ailments, and suggest a way to remedy the difficulty without calling in an expert

FIG. 5
If the bulbs light, pull the plug out, listening for a click in the loud speaker or phones. When these simple tests do not actually show you the way out of your difficulty, a description of the results will be of very great benefit to the Grid Department, or to your local expert in helping you out

lighted, the plate circuit in the last tube is, probably open. This may be additionally ascertained by

Test No. 4.—Pull the phone plug in and out, listening for a click. Change from phones to loud speaker and repeat the test. This will place the difficulty in either the output instrument or within the set. If one pair of telephones give a click in response, it is evident that the difficulty lies in the other. If the trouble is in the receiver proper, and neither phones or speaker work, try

Test No. 5—Place another tube in the last socket and repeat Test No. 4. No response absolves the tube, placing the blame on an open B battery circuit, with the probability that the phones and speaker are in good condition.

Test No. 6—This should be in the form of a *momentary* short, or, better, a voltmeter test across the B battery posts on the set. If current is indicated, this shows the trouble is within the set; the current from the battery has succeeded in traveling as far as the binding posts. No deflection on the voltmeter or spark, if the voltmeter is not used, locates the difficulty on the battery side.

If tests No. 1 or No. 4 show that there is a plate circuit, that the batteries are O. K., the next test on non-regenerative sets (neutrodynes and stabilized radio frequency) is

Test No. 7—It is then possible that there are no receivable stations on, which means that they are off schedule or shut down by an sos. More than one fan has decimated his set during the enforced silence accompanying a distress call at sea. Have someone ring your doorbell, or turn on and off your electric light, respectively while you listen for a rough buzz or clicks in the receivers or loud speaker. These will indicate that in all probability everything is O. K., or that the trouble is in the antenna or ground connections. No results or results below normal, suggest the radio frequency circuit is the source of difficulty.

Test No. 8—With regenerative receivers, those employing detector feed-back and potentiometer or similarly controlled radio frequency circuits, this test will probably precede test No. 7. Turn up the regenerative or "volume" control. The usual oscillations, "plops", or squeal, show that the regenerative detector and audio frequency tubes are O. K. The operator will then proceed to Test No.

7. Negative results from Test No. 8 show a fault in the regenerative tube or tubes or in any of the audio stages except the last, which Tests 1 and 4 proved O. K.

Test No. 9—Tap the bulbs with a pencil, moving progressively toward the antenna connection. This generally means from right to left: second audio, first audio, detector, etc. No ring will be heard in the loud speaker when the faulty tube or stage is reached.

Test No. 10—Changing tubes will almost always eliminate or define the bulbs as the source of difficulty.

Try all these tests when your set is working, immediately when the trouble is discovered if possible, in order to acquaint yourself with the response you may expect from a working receiver.

BUILDING YOUR OWN LAB

WIRE your lab. with an eye for convenience in testing and operating more than one receiver in different parts of the laboratory. The arrangement developed in the R. B. Lab can be enlarged or reduced to suit individual convenience.

Filament and plate batteries are centrally located with charging apparatus, and are wired to the benches using colored wire, often called "code wire."

Six outlets are desirable, which provide for the connections to as many receivers or test apparatus. Seven wires are used. Two differently colored heavy stranded wires carry the A battery current. Four No. 18 annunciator wires of variegated hues, provide plus B battery from $22\frac{1}{2}$ to 140 volts. The negative B is connected to positive A on the battery table.. The seventh wire connects to an outside antenna which may be disconnected by a switch at each of the six outlets.

One hundred and ten volt lines are run in metal moulding along the edges of the benches with similar outlets. The moulding itself affords the ground. The moulding should be installed according to underwriter's requirements, who, however, have no jurisdiction over the other wiring.

If desired, fuses, switches, and meters (volt, ampere and milli-ampere), can be installed at the battery table. Several photographs taken in the Lab. depict the utility of this arrangement.

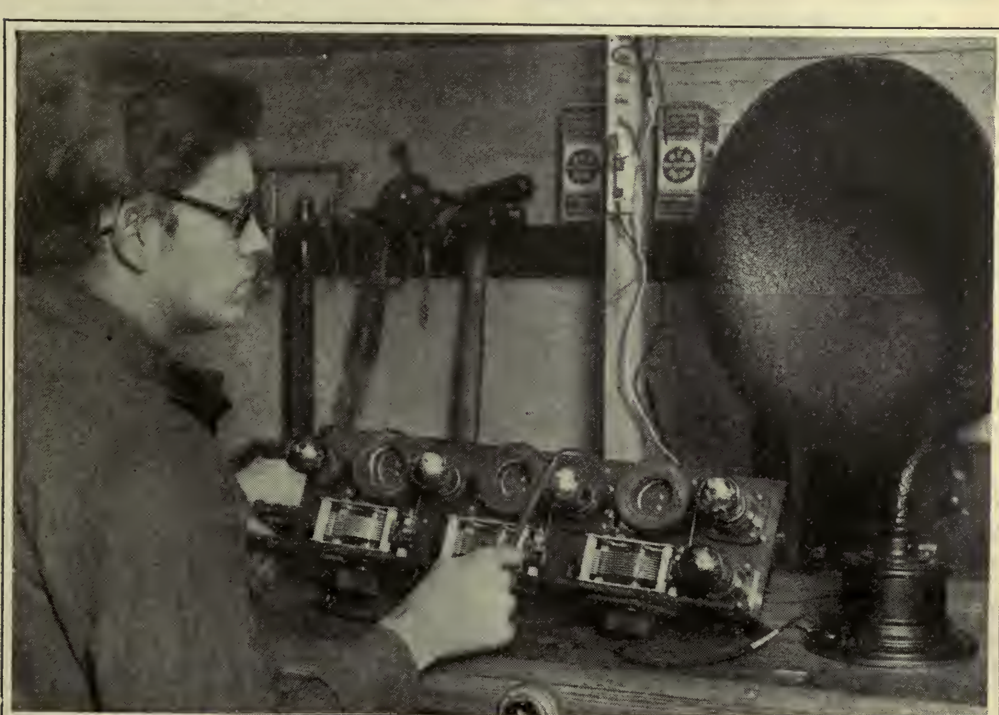


FIG. 6

Tap the bulbs and listen for the usual ring. A ring from any of the r. f. or detector tubes shows that the audio amplifier is O. K.

as the broadcaster sees it
by Carl Dreher

Drawings by Franklyn F. Stratford

How Much Power is "Super-Power"?

HOW big must a broadcasting station be to claim attention as a "super-power" outfit? Estimates appear to vary. The owners and publicity representatives of the 5-kw transmitters now being put into operation in various sections of the country like to refer to them as super-power equipment. But if 5 kw is super-power, what would 50 kw be? We had better be careful, or we shall run out of awe-inspiring prefixes. It is certain that Mr. David Sarnoff, who is responsible for the idea and for the spreading abroad of the term, had a considerably greater magnitude in mind than 5 kw.

However that may be, it is a fact that the power rating of present-day broadcasting stations is trifling compared to that of the great transoceanic and transcontinental radio telegraph installations. One of these immense transmitters is described in a paper by Dr. Cornelius J. DeGroot in the December, 1924, number of the Proceedings of the Institute of Radio Engineers, "The High-Power Station at Malabar, Java." This station connects the Dutch East Indies directly with Holland, arc transmitters being used in the main. At the present time 2,400 kw is the power supply to the arcs, whereby 1,200 kw are fed to the antenna, as compared to 0.5 kw in the antenna of a standard Class B broadcasting station. 1,200 kilowatts! Ten years ago all the man-made radio frequency energy in the world probably did not amount to 1,200 kw. Dr. DeGroot is not satisfied, however. He assures us that when he gets another motor generator from the General Electric Company he will be able to supply 3,200 kw to his arcs, obtaining about 1,600 kw in the antenna. This will put the station on a 20-hour-a-day basis of communication over its 7,500-mile circuit, which is in excess of the traffic requirements.

But, simply regarded as power, 1,200 or 1,600 kw are not figures to arouse respect among power engineers. In a good-sized power plant, such as one of those which supply energy for the subways of New York City, the wattmeter reads in the neighborhood of 100,000 kilowatts on normal load, and this load fluctuates 5,000 up and down. The mere variation in the load carried by such a plant is far greater than the maximum output of the largest radio station in existence.

The comparison is instructive, and chastening to the pride of the radio engineer, but at bottom it really does not mean much, for the commodities are not in the same class. Raw electric energy is one thing, and modulated radio energy—especially that voice or musically modulated—is quite another. Moreover, this difference between simplicity and complexity is only the first of a number of unlikenesses. There is a difference in reception, for one thing. The subway train or the electric toaster takes power from the line and uses it up. Radio receiving sets, in general, amplify, sometimes very greatly, the quantity of energy which they pick up. A super-heterodyne in robust form may possess a voltage-amplifying capacity of from 5,000 to 10,000 times, according to Mr. Armstrong (from 25 to 100 million times energy amplification), and no doubt many receivers of more plebeian types have an energy amplification of millions of times (energy amplification is the square of voltage or current amplification). It should be noted that this development of receiving amplifiers

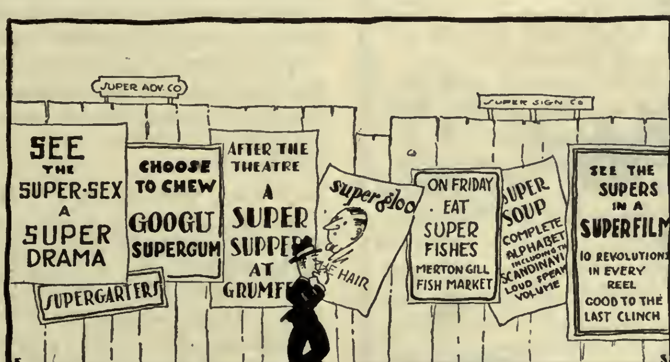
has been necessitated by the great attenuation involved in radio transmission, the losses in the intervening medium being far greater than those of an electric power transmission network.

But the principal distinction lies in the extraordinarily small amount of energy required to satisfy the human ear. "The speech energy output of the normal voice has been found to be at the rate of about 125 ergs per second. If we could have a million persons talking steadily and convert the energy of the voice vibrations into heat, they would have to talk for an hour and a half to produce enough heat to make a cup of tea. This merely serves to illustrate that in terms of power or energy human speech is exceedingly weak. Furthermore, most of this energy is carried by the vowel sounds. At the upper and lower limits of audition it takes about a hundred million times as much energy to enable one to hear as it does in the range of 1,000 to 5,000 cycles, where the ear is most sensitive. At all frequencies, the energy required is small, and in the most favorable region the minimum audible tone corresponds to a pressure change per square centimeter of about 0.001 of a dyne. This pressure is roughly equivalent to the weight of a section of a human hair about one thousandth of an inch long (about one third as long as its diameter)." (R. L. Jones: "The Nature of Language." *Journal A. I. E. E.*, April, 1924.)

Thus a public address system or a moderate-powered broadcasting transmitter may, as has been pointed out, contain more speech energy than all the inhabitants of the globe yelling with all their might and main at the same instant—if they could be persuaded to coöperate to this extent, which I doubt. It is for this reason, basically, that wireless stations are not, relatively speaking, powerful. They need not be as powerful as agencies which light homes or transport freight or press trousers, because these actions require infinitely more energy than speech and hearing, and it is in hearing that radio communication usually terminates. That is why super-power in electrical engineering—the section-wide coördination and integration of power generating facilities—deals with magnitudes enormously greater than the super-power projects of radio broadcasting. The latter, however, assume imposing proportions as soon as we compare them with the energy levels of unaided speech or the general run of sounds found in nature.

Since writing the above I have come across two newspaper articles bearing on this subject. One of them is a publicity release by Mr. J. D. R. Freed, also pointing out that "super-power" is a term too loosely and inflatedly used in radio at the present time. Mr. Freed compares the power of a large broadcasting station like WEAF, with 2 kilowatts in the antenna, with the 665 kilowatts consumed by a ten-car subway train (presumably this is starting energy). An electric sign on Broadway consumes 263 kilowatts. The average broadcasting station of to-day puts into the antenna only about as much power as one needs to light a six-room flat. Mr. Freed's idea of super-power is from 1000 to 10,000 kw for an international program distribution. In other words, he would go up to and above the level of the Malabar transmitter of Dr. DeGroot. The only question we raise at this point is: Who is going to put up the money? Also, in his comparison of power magnitudes, Mr. Freed does not discuss the bearing of the relatively minute energy required by electro-acoustic devices, on the problem of radio power.

However, Mr. Freed is an engineer and what he says is sound and pertinent. At the opposite extreme is a publicity release by a radio and phonograph company which is about to enter the broadcasting field with a "station of tremendous power. It is said that it will have a range of from 15,000 to 20,000 miles." And what is going to be



what does "super" mean?

the power of this colossus? Answer: 5 kw. You may breathe again.

Moreover, the engineer of the company informs the world that this new station will "influence profoundly broadcasting in daylight." This gives the impression, to the lay reader, that the daylight range of a 5 kw transmitter must be somewhat comparable with the night range of the present order of figure 0 .5 kw sets. This belief is entirely erroneous.

Messrs. H. W. Nichols and Lloyd Espenschied, two prominent radio and telephone engineers, investigated this subject some years ago, in the course of a larger work which occupied them at that time, and reported their results in a scientific paper. (Nichols and Espenschied: "Radio Extension of the Telephone System to Ships at Sea," *Proc. I. R. E.*, Vol. XI, No. 3, June, 1923.) They made actual measurements. It was found that in order to equal during daylight the freak ranges secured by radio telephone stations on broadcasting wavelengths (then 360 and 400 meters) during the most favorable times at night, about 10,000 times as much power would be required. A 0.5 kilowatt station would have to raise its power to 5000 kilowatts!

But what's a little multiplier like 1000 to a publicity representative and radio engineer, model 1925? Less than nothing, for these gentry never heard of Nichols and Espenschied and Alexanderson and Wien and Braun and Armstrong and Latour and DeForest and the few hundred other earnest engineers whose exclusive creation radio broadcasting is. And, if they have heard of them, they care no more for scientifically derived data than the Long Island fanatics who recently awaited the end of the world.

we need artistic microphones

Artistic Stands for the Microphone

THE design of microphone stands, at the present time, is far too conventional. They are tame, unimaginative things wrought of bronze pipes or onetime respectable parlor lamps. This has a depressing effect on the whole broadcasting art, for the general public gets its ideas of radio largely from the myriads of pictures showing the great, and the aspirants to greatness, posed before a microphone stand in the attitude of talking to 10,000,000 fellow citizens—even when the station power is about 10 watts. What an opportunity is neglected here! The future belongs to the genius who will express himself through radio microphone stands, fitting them to special situations, somewhat as follows:

A ravishing silver-plated girl in attractive déshabillé for lecturers on literary censorship, denouncers of the younger generation and petting parties, etc.

For Mayor John F. Hylan of New York City, a bust of Gen. John F. O'Ryan, his opponent in the local traction controversy. General O'Ryan could hold the microphone in his teeth.

A foaming stein or champagne bottle for prohibitionists.

At WOC, the learned chiropractors might talk to a mound of issues of the *Journal of the American Medical Association*, the microphone surmounting the same.

For Messrs. Arthur Lynch, Willis K. Wing, and Zeh Bouck, the desperate crusaders for a squealless ether, what could be more appropriate than a gigantic diagram of a single-circuit regenerator, rampant, with the microphone suspended from the oscillations?

The ramifications of the idea are obvious. Its inspirational properties are unlimited. We leave its execution to philanthropists and artists.

Note on Announcing

A COMMITTEE has recently been occupied, in New York City, with the task of raising the standards of announcing. Various conclusions as to rate, pitch, inflections, and other characteristics were reached and duly published.

A most praiseworthy work. But the committee omitted consideration of one funda-

mental fault with which nine announcers out of ten are afflicted: they talk too much.

How and Why Stations Heterodyne One Another

THE problem of heterodyne interference between broadcasting stations has the same origin as the rush hour jam in a large city: too many people are in the same place at the same time.

Class B stations are supposed to be spaced ten kilocycles apart, with an effort being made to reduce the separation to $7\frac{1}{2}$ cycles, in order to create additional channels for new stations. These are theoretical separations, conditioned on all the stations keeping their exact assigned frequency. Unfortunately, they vary. When they get a few thousand cycles apart, all the listeners within range of both hear a beat-note, a continuous melancholy whistle, varying slightly in pitch from minute to minute, and well calculated to drive sensitive persons crazy—although, through the psychological phenomenon of auditory fatigue, some people get used to the beat and hardly hear it after a time, unless it is very loud.

As a matter of fact, any two—or any number of stations, for that matter—have a beat note in any receiver capable of picking up their waves. If they are 10 kilocycles apart, they have a beat note of 10 kilocycles, or 10,000 cycles, which is over twice as high as the highest note on a piano. This pitch is too high to pass effectively through the audio-amplifying circuits of a receiver, and what little does get through is suppressed by the loud speaker and the human ear, neither of which is designed to respond ardently to such an acute note. In short, nothing is heard. But as the two stations, through the deviation of one or the other, or both, from its or their assigned frequency, approach each other, the beat note between them passes into the band of audible and essential frequencies to which the acoustic apparatus of the receiver and listener responds. The resulting interference may be anything from a very shrill whistle up around 4000 cycles, scarcely audible to one not listening for it, down to an angry recurrent growl on either side of zero-beats, if the two stations happen to be right on the same wavelength. Or, it may be a loud, continuous whistle of medium musical pitch. Loudness depends on the strength of the electric fields of the two interfering stations at the heterodyning location; pitch depends on

running down station interference

their respective frequencies and the variations therein. The ultimate result is telephone and telegraph calls from irate listeners.

Unfortunately, a station which is too weak to produce a workable signal in a given neighborhood, is perfectly capable of giving rise to heterodyne interference with stations supplying a powerful signal to the locality on which it depends for program service. This is one of the inherent traits of heterodyne amplification, the same which enables an oscillating receiver to hold a very audible beat-note with a distant station, while, in the non-oscillating condition, the modulation of the station in question is inaudible—a characteristic which is therefore responsible for the reprehensible use of beat reception by users of radiating receivers. Great is heterodyne amplification, and, like many other great things, it is also capable of causing a deal of mischief.

The result is that in, say, New York City, you may be listening to one of the local stations five or ten miles distant, employing enough amplification to get a comfortable signal; and although in that condition your set could not possibly hear a Chicago broadcaster of the same power, when that Chicago station climbs on to your New York station's wavelength, you get a beat-note of perhaps a quarter the intensity of the local station's signal. (Living in New York, and being responsible for the technical operation of two of the local broadcasters, I naturally assume, and stand ready to prove it with wavemeters and firearms, that the Chicago station is at

fault.) But if the New York broadcaster then takes his carrier off the air, and you let your receiver alone, there is silence. You have to bring up your amplification in order to hear Chicago.

This has an important bearing on the problem of running down heterodyne interference when it does occur. The only receiver which can be safely used in such work is one which has a volume control independent of the frequency adjustments. If the tuning and intensity controls are electrically interlinked, I should say that the receiver is worthless for detective equipment.

If you are near one of the heterodyning transmitters, you are not likely to be able to identify the more distant one unless Number 1 takes his carrier off the air. If the interference is serious, and the transmission of the station is properly monitored from a point outside the studio, this is likely to be done. The engineers are waking up to the fact that they can best solve their station-interference problems by direct action, by exchange of telegrams between the broadcasters involved, as soon as the trouble starts. The telegraph companies are generally willing to give priority to such messages. It is preferable to take the carrier off the air for a few minutes, for the purpose of identifying the interfering station, and to send him a telegram explaining the situation, rather than to suffer the condition to continue and to allow the program to be hashed up, in greater or less degree, for the entire evening.

It is customary, when shutting down for this purpose, to take the listeners into one's confidence and to solicit their aid, for, with the great natural variations in receiving conditions, quite possibly some outsider will be able to do the job better than the one or two members of the station personnel engaged in chasing down the trouble. The purpose of this article is to give listeners some data which will make their testimony reliable in this regard.

The rules of the game may be summarized as follows:

1. When the announcement goes out, tune your set precisely to the wavelength of the local broadcaster who complains of the interference. This can usually be done in the few remaining seconds of transmission.

2. If you are receiving on a loud speaker, change to head telephones; your chances with the phones are obviously better.

3. When the carrier goes off the air, bring up your *volume* control till the interfering station is readable. *Don't touch the frequency controls.*

4. If you are able, under these conditions, to make a positive identification, and you feel inclined to do that much for the cause, dispatch a telegram to the party of the first part who has gone off the air. The next best thing is to write a letter.

5. If the intensity and wavelength (frequency) controls of your set are not perfectly free from interaction, or if you are not confident that your set tunes very sharply, you can be of greatest service by staying out of the controversy. Your testimony will only confuse the issue.

Of course, if you have a set accurately calibrated in kilocycles, it may be permissible to try to determine the actual frequencies of the stations involved, but with ordinary equipment one is not justified in testifying that Station Number 2 was actually on the wavelength of Station Number 1 unless the frequency-determining elements of the receiver remained unchanged. Even this, of course, is only a beginning, for Station Number 1 may have been off his wave. Once it has been established, however, which stations have been involved, it is usually possible to clear up the situation for the time being, and the accurate calibration of their frequency indicators must be left to the Federal radio supervisors.

The necessity of instructing the listeners in the above procedure, if they are to be of service in these situations, was brought home to me by a recent incident. I was listening at my home when one of the stations in which I am interested developed heterodyne interference early in the evening. Program complications made it inadvisable to interrupt the service later, so I telephoned immediately and had the carrier taken off the air for four minutes. Before these instructions could be carried out the interfering station shifted his wavelength, and the beat-note ceased. It was too late to cancel the order, and the carrier went off. I listened on the chance that the distant station might come in again during the four-minute period of observation, but heard nothing except two extremely distant transmitters heterodyning each other, and a spark station in the English Channel. As soon as the carrier went back on the air, Dr. Alfred N. Goldsmith telephoned me to say that he also had heard nothing to indicate that any one was on our wavelength, and that on his specially calibrated super-heterodyne both of the out-of-town stations which occasionally clash with us were on their assigned frequencies. Dr. Goldsmith is the chief broadcast engineer of the largest radio company in the world, and has been making precision measurements in radio for about fifteen years, so that what he says must be accepted as *ex*

cathedra. But a considerable number of listeners notified the station that X and Y, the two transmitters with which we sometimes have difficulty, were on our wavelength. We know that at this particular time X and Y were innocent. Clearly our well-meaning informants were wrong in their conclusions.

As long as only two stations heterodyne each other, there is hope, but in the not infrequent case where three transmitters are involved, one can do little but sit back and stand the gaff. Generally, when one carrier is taken off the air, the remaining two beat with each other to such a degree that the announcements of neither can be understood. The only thing that a broadcaster in this situation could do would be to shift his own wavelength and get clear of them both. But that is reprehensible, for if individuals start taking the law or the wavelength into their own hands in this way, the present difficulties of ether congestion will become aggravated to the point of chaos. Such a remedy is worse, in the long run, than the disease. Communication and coöperation between broadcasters should all be in the direction of keeping every one on his assigned frequency. If the stations will only stay put, we shall be able to say, as far as beat interference is concerned, "The rest is silence."

Who is Which in Radio—Colonel Combust

ON OUR recent trip abroad we carried letters of introduction to Colonel Combust, the Chief Signal Officer of the unmatched Euphratean army. We had considerable difficulty catching up with Colonel Combust, for the Euphratean forces were just then retreating before the matchless Kustanian army, a war having sprung up between the two monarchies over a chorus girl. Finally the officer was located, standing up to his mustache in a river, and waving his sword to encourage the brave Euphrateans who were swimming around him. Delivering our letters through an orderly, we hove to in our rowboat, waiting for a statement.

"We shall deceive the enemy," cried the gallant colonel, "for the code our signal corps operators send is absolutely unrecognizable, even by ourselves. Therefore the cursed Kustanians will be unable to discover our designs, our arms will triumph, and the lovely chorus girl Tina will be restored to the Euphratean "Follies," from which she was wantonly kidnapped by the King of Kustania, that insolent pig!"

As the valiant colonel swung his sword close to our nose during this denunciation, we rowed several boat-lengths upstream before asking:

"Has the King of Kustania no chorus girls in his own dominions?"

"He has," explained the colonel, "but his taste in that line is exotic, like that of a DX hunter, who praises the stations of every country but his own."

"Are you, then, afflicted with broadcasting stations, sir?" we inquired.

"Yes, indeed," answered Colonel Combust, "and I predict with confidence that, after we have defeated the enemy in this present war over Tina, the next war between Euphratea and Kustania will be brought about by the broadcasting stations."

"What!" we cried. "We understood that broadcasting was to lead to universal peace, the hearts of the Mongolians, Californians, and Esthonians being softened by mutual listening to bedtime stories, lectures on the dog-collar industry, and reports on measurements of the losses in No-Loss variable condensers. Nay, more, we had worked out a plan whereby all international disputes were to be settled, not by citizens shedding each other's blood, but by the announcers of the several countries being allowed and incited to talk each other to death. Thus an orderly and beneficial process would be substituted for barbarous warfare. What could be sweeter than to have the announcers die for their countries, while other citizens continue to hug their girls—"

"Whose girls—the announcers'?" interrupted the colonel with great interest.

"Announcers have no girls," we exclaimed impatiently. "The conjugal tie cannot long unite two such verbose entities as a woman and an announcer, and girls, realizing this

the boat oscillated like a blooper

fact, do not waste their time on the gentlemen of this trade."

"Nature is wonderful," agreed the doughty officer.

"As we were saying," we continued, "the announcers will perish, but respectable realtors, cheese-brokers, and clothing dealers will continue to drink chocolate sodas and to roll the bones. No longer will war ravage and impoverish countries. Such, at least, was my plan and expectation. And now you, Colonel, tell me that the great nations of Euphratea and Kustania are on the brink of another war—when they finish the present one—over a question of broadcasting stations! Oh, Colonel——"

Such was our agitation that we stood up in the rowboat.

"Sit down," called the officer. "You are rocking the boat."

Indeed, the boat was oscillating like the single-circuit receiver owned by the janitor's little boy. We sat down.

"Nothing could be more natural," Colonel Combust asserted. "The Euphratean engineers having erected a 3-kilowatt station, immediately the greasy Kustanians proceeded to put up one of 10 kilowatts. Is not that a *casus belli?* Shall we hesitate to defend our national honor?"

"But, sir," we assured him, "does any one doubt that three Euphratian kilowatts are worth ten Kustanian kilowatts?"

"Absolutely," cried the Colonel. "But you should hear the modulation. It is an atrocity. The whole world should make war on a country which permits such distortions in the ether."

"Don't say that, Colonel! On that basis, will not the League of Nations attack Newark, New Jersey, and stab it in the lower wave-lengths?"

committees are judging announcers

"Why not?" inquired Colonel Combust, undisturbed, as ever, at the prospect of another war. "The surrounding marshes will be eternally grateful to any power which delivers them from some of those Class A coffee-grinder broadcasters."

"Besides," he continued, reverting to his favorite subject of the disputes between Euphratea and its hostile neighbor, "why should Kustania have a broadcasting station at all? The miserable Kustanian goatherds have no more valid use for such an apparatus than a football player has for a *brassière*."

"Are they deaf and dumb, then?" we asked.

"No," answered our informant, "although it would be a blessing if they were. You should hear their so-called broadcasting. What uncouth speech! What asinine arguments! What unadulterated drivel! Music such as little children make on their drums and fish-horns on Christmas! It is indescribable. One must hear it. But, as you seem a well-meaning and moral young man, I pray that you may be preserved from such an ordeal."

"Colonel, you speak exactly like one broadcaster about another in the same town—in my country. They refer to each other, reciprocally, in such sweet terms. But this is a conflict which we cannot resolve at the present time. So tell me, Colonel, would it not be possible for you to issue forth from this river and have dinner with me in that town I see on the horizon?"

"It would be bad tactics," answered the immersed officer, regretfully. "We have strategically placed our superb army in this river because the despicable Kustanians have 60,000 more men than we. But, such is their fear of being washed, that they will not venture near a body of water of this size. Thus by remaining in the river we are carrying the war to a glorious conclusion."

"The sensation of hunger," writes the physiologist Cannon, ". . . . may take imperious control of human actions." A journalist is human. Hunger forced us to take leave of the heroic Colonel Combust and the other brave Euphrateans. When we had rowed about fifty feet towards the shore the Colonel hailed us.

"Sir, will you grant me a great favor?" he called. "Bring me back a ham sandwich and a water-proof radio receiver."

"Why the radio receiver?" we asked. "Would you not rather have two ham sandwiches?"

"No," answered the valiant soldier pite-

ously, "my feet are cold, and I would warm them by listening to the strains of 'Red Hot Mamma' broadcast nightly by 500 American stations."

Unfortunately, when we returned the river had frozen over from shore to shore, and no sign remained of the great-hearted colonel and his army. Furthermore, the Kustanians beat us up to within an inch of our lives for affording assistance to the enemy. We are proud, therefore, to present to our readers this last interview with Colonel Combust. *Requiescat in pace*—which, translated, means, May he freeze in peace.

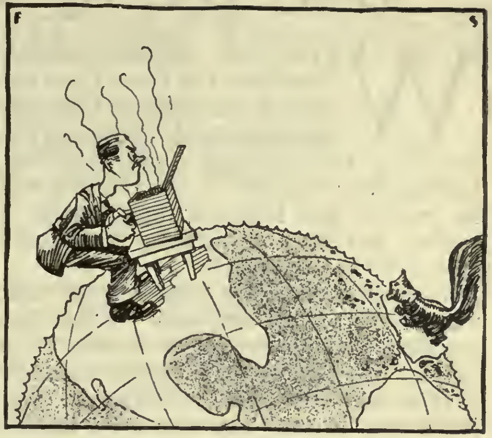
Why Should Radio Appeal Only to the Auditory Sense?

THE quotation with which we are now about to grace this crude and materialistic department is ladled out from the daily sugarwater offering of a metropolitan radio critic:

> Deferring to the guest of honor's habitual aversion to radio, broadcasting forces had tactfully concealed the microphone among masses of flowers. Their sweet odor was infused into the words of the speakers, which transmitted with unusual clarity in spite of the blossomy screen.

A sweet odor was infused into the words of the speakers, ladies and gentlemen. Observe that honeyed figure of speech.

However, this is not the time to make my confessions in full. What I started out to develop was a speculation on the relation of radio to the various senses of a human being, as suggested by the above quotation. Is it conceivable that odors will ever actually be transmitted by radio? It certainly is. In radio telephony we start with a microphone, which changes sound waves to electrical impulses; the rest is easy. In the photoradiogram processes which have recently been demonstrated, we allow light to impinge on a photoelectric cell, the light waves are transformed into electrical fluctuations, and photographs are sent over the ocean. Anything that can be translated into electrical energy can be transmitted by radio. Hence why not smells? The sense of smell involves the chemical action of vapors, essences, gases, or finely divided particles brought into contact with special organs of sense, the olfactory nerves. All we have to do is to invent an olfactory-electric cell, containing suitable chemical reagents, which will generate proportionate and appropriate electrical impulses



smelling a civet cat across the world

when exposed to vapors, essences, gases, or finely divided particles suspended in air; and the rest is a cinch. When that dingus is invented—and anything can be developed if the Board of Directors will appropriate enough money—we shall be able to smell a civet cat or a piece of *fromage de brie* across the world. Oh, but that will be a glad day!

When will it dawn? No one who has given due heed to the human mania for invention can doubt that it will arrive. But when? Not immediately. For those who insist on figures, I am glad to estimate that its chances of arriving within the present century are only 314 in 1,000,000,000,000,000,000,000,000,000. Our readers will recognize this proportion immediately as being of about the same order of magnitude as the probability of M. Leon Trotzky voyaging to the United States to address Congress and to become a master of boy scouts.

The second portion of this learned treatise occurred to me while I was engaged in some research work of a medical nature. It appears that when a man dies the senses usually fail in the following order: smell and taste, sight, touch, and hearing. The significance of this to broadcast listeners is obvious. In the physiological turmoil of dissolution, when the individual is no longer responsive to odors, tastes, spectacles, and contacts, he can still harken to his favorite broadcasting station. He can hear that, more or less, until he blows up entirely. There is an assurance which should destroy the fear of death! If any patron of broadcasting wishes, in gratitude, to send me a check for $10,000, my address may be obtained from the Editors.

ON OUR BIRTHDAY

WITH this number, Radio Broadcast is three years old and we are going to take this opportunity of climbing to the house top and shouting about ourselves. During the remainder of the year, we will be modest and hide our light under a bushel, but on our birthday we should have a bit more latitude.

We feel that we are doing the job that we set out to do pretty well. If this presumption is unwarranted, we invite you to tell us wherein we have failed in order that we may not appear to fail again. Our job is not an easy one and we're human just like you, and we not only can, but sometimes do make mistakes. As a rule our mistakes are brought home to us in no uncertain terms, but there may be a few we've made that you haven't told us about.

DURING the last three years we have been plugging along with ideals, which, for a while, seemed like the pot of gold at the rainbow's end. These ideals are approaching nearer to actuality all the time. Our first and perhaps most important ideal from your point of view is a desire to present to our readers the best technical information that research makes available. It is with considerable pride that we recall having published the first article on a transformer-coupled super-heterodyne, and another article describing various important experiments with the "super." It is significant to note that literally hundreds of "supers" have been described by other publications and that we find our first set for home construction is just about as good as any of the newer types—with the single exception of the Hanscom super-heterodyne, and that receiver saw the light of day in our own pages.

There are other circuits we have described in the magazine during our short three years of publication. The Knockout series of receivers have been tremendously well received by readers of the magazine in practically every part of the world, and if the letters which you, the reader, write us, can be accepted as any indication, that series is becoming increasingly popular. And these receivers are popular, we feel, because they fill a very definite want among radio constructors. Our criterion is "Such a receiver and circuit must be reliable and technically sound. It must be helpful and useful to the radio constructor." These requirements, we feel, our construction articles have fulfilled.

And while we're on the subject of circuits, it is in order to say a word about our attitude toward "trick circuits." We never have and never will publish any construction articles on trick circuits. Our ideal is the publication of one extremely good "how to make it" article a month. If it employs a new, but good circuit—such as the two-tube super-heterodyne we have up our sleeves for next month—so much the better. If on the other hand, no really new circuit is found, a more satisfactory arrangement of an old but good one is, as a rule, of real value. In March of last year we published an article entitled "The Truth About Trick Circuits." One gentleman whose circuit was rather severely criticized in the article brought suit against us in court for $100,000 damages. Fortunately for you and for us, the jury decided in our favor. We shall continue our policy of telling the truth, even when it hurts.

AS A parting shot, we cannot resist mentioning the International Radio Broadcast Tests which were conducted by us for the second time last November. To you we owe a vote of thanks for your coöperation in making them a success. And they were more successful than anything of the kind ever attempted. From last year's experience we have learned much which will make our work of preparation for next fall much more effective.

Everything considered, we have had a fairly good and profitable time together during our short friendship, and our plans for the immediate future will, we trust, meet with your entire approval. As an example of some of our plans, we are glad to announce that we are going to add eight pages of text beginning with the June magazine. We greatly appreciate your friendly support and trust that our efforts in the future will warrant its continuance.

Arthur H. Lynch.

New Fashions in Radio Programs

How the Present Trend of Radio Advertising Is Improving the Quality of Broadcast Programs—A New and More Intelligent Rôle for the Announcer —What the "Balanced Performance" Means to the Radio Listener

By JAMES C. YOUNG

ANYBODY who has listened-in on the radio knows that weary feeling which sometimes steals upon the heart when the announcer reaches the next number. As for the announcer, he is a man worthy of kindly thoughts. He must go through 365 nights in the year, announcing anything up to a dozen numbers every night. And he must endeavor to introduce each one in an original way.

Some announcers are businesslike and crisp. They stick to their subject. Others affect the grand manner and cultivate theatrical inflections of the voice. Some others—alas! —turn to humor. That is the most painful method in the end. But whatever the method, the announcer has one of the hardest jobs in the radio business. He strives to make himself interesting every evening, and he must attempt the thing with the same old tools. We know in advance, every trick that he can play yet we must listen and hope for the best. Only a brave man would apply for the job. There should be a certain award in paradise for every announcer.

Of all the announcers known to the radio public, the noted "Roxie" has gained the surest hold on popular favor. His methods are distinctly personal and highly successful. He is the leading man of his own program and probably known to a larger number of followers than any other personality associated with radio.

Interesting things happened when the men higher up at WEAF undertook to edit "Roxie's" little monologues. For some time WEAF has believed that the endless repetition of announcements was trying on radio nerves. And WEAF suspected that "Roxie's" monologues were somewhat trying as well. Therefore the blue pencil went into his talk about the old folk back home and the condition of Aunt Matilda's health.

On one eventful Sunday night several months ago "Roxie" out-did the most stilted introduction known to radio. A host of followers listened and wondered and became amazed. What was the matter with "Roxie"? Next day the papers told them. He had been edited. Immediately an almost unanimous protest poured in upon WEAF, the greatest expression of opinion ever drawn from a radio audience. There was plenty of static in that protest. It spluttered a good deal, demanding that the editorial frown be removed from "Roxie's" copy. And WEAF relented, without even putting an ear to the ground. Such is the public estimate of one announcer who has caught the popular favor. But he is almost alone among a multitude. For some time it has been evident that radio must

So This Is Advertising!

For some time, radio listeners in the eastern and central parts of the United States have listened faithfully every Tuesday night at nine to the entertainment given during what was called the Eveready Hour. These programs have differed from the usual run of radio entertainment, for they have been presented as a complete unit. And they have been well done. The idea of making a radio program follow one plan or idea for several hours at a time is not new—WGY and others have used it in the radio play, and WJZ made some sporadic efforts along this line with their "Spanish Night" and others. Radio broadcasting is nothing more or less than good showmanship, and as Mr. Young points out, we cannot expect the announcer to do constant marvels with an old bag of tricks. The step in broadcast programs which the author describes so interestingly is a real forward and important one, we believe. One frequently hears the fear expressed that broadcast programs will eventually turn into nothing but constant and very insidious advertising, but it is our opinion that the natural adjustment of things will prevent the overloading of the air with advertising that is objectionable.—THE EDITOR

evolve a better method of presentation for its programs.

It was this kind of reasoning that led to one of the distinct innovations in radio, a dramatic program presenting music and theme in a form of continuity which holds many possibilities. When radio was new somebody perceived the need of a cue to what the programs meant, and that brought in the announcer, of whom great things were required. He has met the task well, but the continuous program, built in dramatic sequence, will make his work considerably easier for himself and the listener.

Instead of bobbing up every ten minutes, like those in a class, he can make one announcement in an hour and try to do it in a humanly interesting fashion. No tricks are required, just a plain statement of what should be a few pertinent facts. Then the continuing theme must keep alive the interest created, constantly reminding the listener of the general trend, but steadily developing the performance as it is done in the theater, on the screen—everywhere the drama has an influence. This, in fact, is the true radio drama and not a hybrid adaptation such as the reading of a play. Radio has developed every means of expression peculiar to itself and it is thoroughly reasonable to suppose that its own kind of drama will be the next step in evolution.

That stage is now opening before us, if we may believe the evidence furnished by one successful broadcaster, responsible for the performance known to a national radio audience as the Eveready Hour. Promptly at nine o'clock each Tuesday night the entertainers in this group take over the air as controlled by WEAF in New York. For the next hour, some millions of Americans are entertained in a way distinctly new to radio. WEAF transmits the program to ten other stations, WFI, WCAE, WGR, WEEI, WEAR, WCCO, WWJ, WOC, WSAI, and WJAR. And for sixty intensive minutes an invisible audience equal to the population of many nations may enjoy a real radio drama.

SOMETHING GOOD DOING EVERY MINUTE

HOW is the thing done? The answer to that question goes back a little way. The first attempt grew from an acute sense of the elements lacking in a typical program, which too often has reached the point where the old minstrel show wound up. No matter how clever Mr. Bones might be, it was not possible for him to continue longer than he did. And the announcer in a large measure corresponds to Mr. Bones. He is supposed to say something clever whenever the show lags.

The Armistice Day program of last year for the Eveready Hour was a notable example of what can be done to brighten a radio performance. The announcer made known in an easy, conversational way that his listeners were to think of themselves as the men inside "a sleeping stretch of tents, thousands of men at their rest. The sun has just risen; the guard has raised the flag and our slumbers are broken by reveille, 'Oh, How I Hate to Get Up in the Morning.'"

Here was a bit of rapid fire psychology at its quickest. The listener instinctively handed over his imagination to the entertainers and let them do with it just about as they pleased. This quality of imagination accounts for a fair half of the success which attends any program. And this is the way the entertainers proceeded, a quick succession of voices:

Sergeant: "Fall in! 'Ten-shun! Right Dress! Front—Count off."

Then the other voices came into play in a way familiar to a large number of listeners: "1—2—3—4. . . . . . . 1—2—3—4". . . . Sir, the company is formed."

Any man ever in the army, or whoever had a friend in the ranks, or who even knew anything about the war, must be beguiled by that kind of introduction. Then the Captain speaks:

"Sergeant, after mess march the company to the Y hut. There will not be any drill this morning. The Eveready entertainers have come to camp and they will put on a show this morning. That's all, sergeant."

This was getting over the difficult business of introduction in a way to please and charm and not once to jar the senses. Next came the assembled voices in the supposed Y hut, evoking memories of 1917, when the world seemed as if it might be going to pot. After a period of singing, the announcer speaks again, but he has become a monologist by this time and we feel friendly toward him instead of wishing that he would get through once and for all and keep quiet. This is what he says:

"We've come to the day when tin hats have been issued and the boys are laying bets that they will sail soon. They win. We're on the transport. There isn't much noise permitted as the big hulk creeps out of Hoboken in the blackness of early morning, but many of the uniformed passengers feel like singing." And they do sing, just about what-

ever they like—"Good Bye, Broadway," "Over There," and "'Till We Meet Again."

If a listener could resist a tug at the heart when that last song died out he would be a strange sort of American. But it has not been recorded that anybody failed to keep spiritual company with the transport on its eventful way. Then comes France: danger, war, and death. At the end, "Flanders Fields" is declaimed to music, and taps sounded.

UNITY AND INTEREST FOR THE PERFORMANCE

THAT is an excellent example of the continuous dramatic performance by radio. It is the same kind of vehicle that once was used to carry along the old variety show when it began to emerge from a number of disjointed acts, which afterward became vaudeville. Although vaudeville is a reversion, in a measure, it is a performance requiring no interpretation by announcement. Even the boy who used to come out and change the signs has disappeared, and now an electrical device supplies the information that the next act will be the performing seals.

Although radio has not offered us the seals as yet—at least, not under that description—there is a wide field of development possible by the adoption of the continuous theme. The idea was not wholly original with the group of entertainers who have scored so successfully by this means, but they at least have utilized it with more definitely successful results than any other group. Therefore they must receive recognition for their efforts, along with the men in charge.

There is virtually no limitation on what may be done with the dramatic theme by radio. Another of the Eveready Hours was devoted to a performance described as the Age of Man program. This choice arose from the wish to present a program of old songs in a new way, attempting to escape from the boresome device of an announcer with trembling voice who talked about the days down on the farm. That sort of introduction is particularly bad when the announcer speaks about a farm with all the intimate acquaintance of a native New Yorker. In this case the introduction was managed to the accompaniment of a piano and violin playing a lullaby, which swiftly developed into "Rock-a-Bye, Baby."

CLEVER THEATRICAL MECHANICS

IT IS not an easy matter to prepare the mind of a radio audience in something like two minutes for such a song as "Rock-a-Bye, Baby." Everybody in America has heard that lullaby so often at all stages of life, that it must be particularly well rendered to hold the attention. It cannot be literally thrown at an audience, as so many songs are tossed

MEMBERS OF THE RADIO ENTERTAINERS

Grouped during a typical Eveready Hour. They are: Left to right, seated: Charles Harrison, tenor; Beulah Young, soprano; Rose Bryant, contralto; Wilfred Glenn, baritone; all of the Eveready Mixed Quartet; standing beside Mr. Harrison, Graham McNamee, announcer; standing behind Mr. Harrison, A. J. Klein, noted African hunter; standing to Mr. Glenn's right Edward Berge, pianist; Alex Hackel, violinist, and Jacque de Pool, cellist, of the Eveready Trio. Others are chorus singers selected from the New York Oratorio Society and extra orchestral players

through the ether. "Rock-a-Bye, Baby" requires gentle treatment and a sympathetic mood.

Well, this particular evening of old songs was pronounced one of the biggest things done in radio entertaining for months. A response from far and near showed that the program landed in the psychological center of the public favor. This program progressed from its opening number with such music as Brahm's "Cradle Song," gradually advancing through the songs of boyhood, youth, and the courting age. Then the songs went on to the succeeding stages of life and what obviously must be the last—Home, Sweet Home.

Still another successful program was made up of sea songs, a class of musical composition especially suited for radio because of the long lilt to the melodies, which seem to slip onto the ethereal waves with a genius all their own. A departure still further afield brought before the microphone one Martin Christiansen, able seaman turned taxi driver. And the announcer made known that Christiansen literally was going to tell "the story of his life." Of course, he did not express the matter just that way. Instead, he explained that some time before, Christiansen was sitting on the box of his cab in New York, reading a morning paper, when he chanced to see in the news that William Beebe was homeward bound from the Galapagos Islands, one of the lost places of the Pacific.

Christiansen read that item and rushed down to the dock so that he might greet the only man he had ever heard about who knew those islands. Christiansen was on the dock when the explorer arrived and the story he told Beebe afterward constituted a rattling good chapter in the explorer's book about those islands. All of that explanation was packed into a few sentences by the announcer, who then turned over the air to Christiansen, and let him speak for himself. He was the sort of man fully capable of that effort and proceeded along this line:

RED CHRISTIANSEN

The "sea-going" taxi driver of New York whose adventures in the lost islands of the Pacific were seized upon as material for one presentation of a new type of radio program

SOMETHING DECIDEDLY NEW

"WELL, I suppose the story begins when I signed up with the bark *Alexander*, down on the other side of the world. That was at Newcastle, New South Wales, in Australia. The *Alexander* was loaded with a cargo of coal bound eastward across the Pacific for Panama. She carried a captain, mate, cook, and sixteen of us men."

Now almost every boy in the world has wanted to be a sailor and practically every girl has feared that her first sweetheart would run away, as he threatened, because she refused his manly hand. The appeal of the sea is universal. It is probable that no other class of fiction ever written is read by so many people. If Christiansen's introduction of his story had appeared upon the printed page, instinctively we would have moved a little closer to the light and have settled down for an evening's joy.

That is what happened with the radio audience. Who can imagine a man telling us about sailing on a trip like that, without every poor landlubber lending eager ear? Christiansen was better than a passable story teller. He went on in this strain:

SCENES IN THE GALAPAGOS ISLANDS

Often called the lost islands of the Pacific, which William Beebe, the noted explorer and scientist, investigated some years ago. A taxi driver in New York, who had been a sailor shipwrecked on the islands appeared on a radio program and described his experiences there. Broadcasting programs of a high order are tending toward better unity and the "Explorer's Night Program" in which Mr. Christiansen took part from WEAF and connected stations was one of this new type. The center cut shows a giant marine lizard which exists only in the Galapagos Islands. It lives in the sea and is about five feet long. The upper left picture shows specimens from the sea being gathered from the yard-arm of the exploring ship. The upper right photograph shows a huge boa constrictor caught near the Islands. The lower left picture is of a giant marine lizard feeding in the surf. The lower right shows a Hoatzin fledgling, the missing link between the lizard and the bird

"I had been living in a sailor's boarding house, run by Nellie Simonds. The day we shipped, Nellie rowed out in the bay and brought some refreshments along as a parting gift. I don't mind telling you that her brand of refreshments made a bigger hit with us than the stuff we had to drink before we got through that voyage. As the tug took hold and started off, we sang to her and she sang back. It was a happy send-off."

That immediately opened the way for the quartette to sing one of those good-bye songs, and the quartette performed in fine fettle. Then Christiansen went on again. Before he stopped talking, there was hardly a radio ear in some thousands of miles that was not aquiver with his story about those forsaken islands and the things that happened there. It was such a yarn as Stevenson would have liked to spin. A listener could experience for himself all the heartache, thirst, and peril that went into the sailor's adventures. In the end, it was pleasant to know that he had adopted the comparitively easy and safe pursuit of driving a New York taxicab, although many men of a less eventful past might call that high adventure.

The Christiansen story was a new endeavor in many ways, and received wide recognition from the press.

THIS IS ADVERTISING

WHO would ever undertake, let us say, to link the yarn of a sailor's adventures with advertising? And the Eveready Hour entertainers, of course, represent the idea of selling by publicity. Here is a development so broad that the possibilities cannot be even

EXCELLENT CLASSICAL MUSIC

Is given during the Eveready Hour by the Mixed Quartette, which consists of Wilfred Glenn (left), baritone; Rose Bryant, contralto; Beulah Young, soprano; Charles Harrison, tenor, Tom Grisselle. During the specially arranged hour of entertainment, given each week by this organization, each is a complete entity. The program by this group and others of the organization is part of a completely balanced program which has been well received by the listeners

estimated. We may conceive of a new expedition to the pole so that the explorer shall describe to us how comfortable he was in some particular brand of knit underwear, while he drank a special blend of tea and munched upon a soda cracker of national reputation.

Whatever are the developments in store for us, the established fact is that a sailor's tale of perilous deeds in far places makes mighty interesting material for a radio program. This is a far step from the day not long past when the only kind of discourse known to radio was the sort which dealt with the advisability of accumulating enough for old age by smoking one cigar less every day. Nobody will fall out with the wisdom of that discourse, but it hardly was entertainment. There has been no perceptible diminution in the consumption of cigars nor any appreciable gain in the total of savings from the thousands of such lectures forced upon the ear of the nation.

But if we know the human heart at all, we cannot doubt that Christiansen's yarn will be talked about around uncounted firesides for many months. It was the kind of tale to make everybody huddle closer to the hickory log—or even the radiator—and bless their stars that those islands with the terrible name are so far away. By association, those who heard the story at first hand will long think of it as a part of the Eveready Hour program. And the programs just as inevitably are associated with national advertising of the wares behind them.

Such considerations lead naturally to the oft discussed problem of where advertising legitimately stops—or begins—in radio broadcasting. Whatever the ethics of the case, it is beyond dispute that radio advertising has increased greatly within recent months. It is in a fair way to equal the power of the accepted advertising in newspapers and magazines. So far it usually has taken the indirect form. But the appeal is none the less direct, we may be assured by the large number of concerns turning to this method.

At a moment when the country is enjoying a broad prosperity, radio advertising would seem to have entered upon a period of development that will surpass anything ever known. The experiences of the automobile industry and the movies are being repeated anew. All of these considerations may or may not interest the radio user. What he seems to care about principally is the quality of entertainment offered for his amusement. Certainly that quality grows better every day and the element of originality introduced by the entertainers in question, under the immediate direction of Paul F. Stacy, suggests a means of enlivening the radio program for the benefit of everybody.

The day evidently is not far removed when the typical radio program will cease being its present jumble of odds and ends put together on the general pattern of Joseph's coat. We may expect a balanced performance, to use a theatrical term, and it is not improbable that an entire evening's entertainment will be presented by the medium outlined. It should be possible to arrange such a program so as to encompass a wide variety and still preserve the theme of continuity. A theatrical setting of the kind suggested on the transport and the canteen would be easily adaptable to lengthy performances. One of the first dramatic principles holds that the continuity of time, place, and action best assures command of attention.

Whether this development be great or small, the radio audience of America at least may be thankful to the Eveready Hour entertainers for introducing a device to help out the hard working announcer. Poor fellow, he has labored nobly, turning phrases around, trying to be humorous and grave, and otherwise experimenting with the tools in his kit. Although there may be nothing distinctly new beneath the sun, it is certain that the continuous dramatic theme for radio programs is a decidedly fresh and pleasant departure "on the air."

GUGLIELMO MARCONI has written an article for RADIO BROADCAST which will appear in an early number. He writes of his recent experiments, in England, at sea, and aboard his yacht, with radio transmission by his famous "beam system". Signor Marconi firmly believes that beam transmission of radio energy on very short wavelengths is a general development that is now upon us. This article is the first that Signor Marconi has published in America describing what he believes is a revolution in radio transmission.

Do Weather Conditions Influence Radio?

A New Theory, Advanced by a Climatologist, Tending to Prove That Atmospheric "Highs" and "Lows" and Other Weather Phenomena Affect Receiving Conditions

By EUGENE VAN CLEEF

Ohio State University

IT IS certainly not uncommon to hear radio enthusiasts say, "I couldn't get much last night, too much static," or "Bad night last night, couldn't get a thing from the west and just a few eastern stations," or again, "Can't expect results to-night, too rainy." Correct as the reports may be as far as actual poor reception is concerned, the diagnoses are not always true. This is because the average person is unacquainted with the mechanics of the circulation of the atmosphere. He knows that the weather changes, but does not appreciate fully the direction of these changes and the part which atmospheric pressure plays in our daily weather.

Weather, of course, is local at any given time. One could well say that weather travels, and the weather which a given city west of us has to-day, may be the kind of weather we shall have within the next twenty-four to thirty-six hours. This suggests that a certain brand of weather is not universal at a given time of day or night, but that there may be a radical difference in the state of the weather at the broadcasting station and that where the receiving instrument is located.

The weather in the United States changes because of the influence of shifting atmospheric pressure areas known technically as Cyclones and Anti-Cyclones. In the cyclone, the air in general blows spirally inward, upward, and in counter-clockwise fashion. In the anti-cyclone, the air blows spirally downward, outward, and in a clockwise direction. In neither pressure area is the movement violent. The diameters of the storms may be anywhere from 400 to 1500 miles. These pressure areas are not always symmetrical in form and consequently their diameters may vary along a dozen different radii.

These storms travel across the United States in a general easterly direction, entering the United States either from the southwest, west, or northwest and leaving by way of the Atlantic coast, but most often by the St. Lawrence river valley. In the autumn months, September to November, hurricanes and violent cyclones, may enter the United States from the southeast in the vicinity of Florida, penetrate at times as far as the Galveston coast of the Gulf of Mexico, and then following the customary paths across the eastern half of the country. The hurricane is the exception and not the rule.

Talk—Minus Facts

THOSE interested in radio have for years tried to find out the factors which influence the radiation and reception of radio waves. There have been a number of theories adduced to explain the sometimes peculiar variation of the signals. Probably best known of such theories is the Heaviside layer theory, which, very briefly, assumes that the various ionized layers of the upper atmosphere refract, absorb, or aid the waves in their passage. Radio Broadcast does not assume responsibility for Mr. Van Cleef's conclusions that weather conditions definitely affect radio conditions, but we should like to observe that his findings seem to fit in very well with what actually is the case. It is quite possible that atmospheric conditions have a definite and yet unexplained relation to the variations in the Heaviside layer. It may be, too, that the findings of this experimenter can be put with the conclusions of other experimenters and relations between phenomena as yet unknown may be seen. At least, the author has done a genuinely good piece of work. Those who have similar access to national weather information should be very much interested in continuing and checking these conclusions.—The Editor

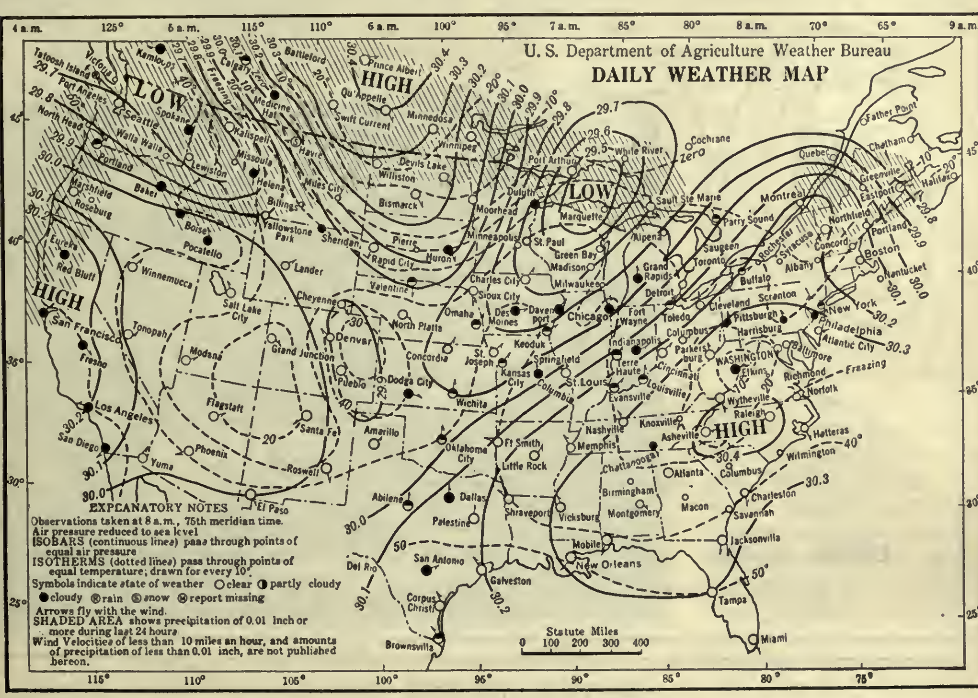
THE IMPORTANCE OF LOW AND HIGH PRESSURE AREAS

CYCLONES and anti-cyclones pass across the country approximately every three to four days, varying in frequency with the season of the year. They always occur alternately. Two high pressure areas (anti-cyclones) or two low pressure areas (cyclones) never succeed each other. "Lows" and "Highs," as they are named on the weather map, always alternate. Meteorologists have studied the variety of weather associated with these pressure centers, and through the agency of the United States Weather Bureau, the forecasting of the passing weather has attained a fair degree of accuracy.

In general, it may be said, that cloudy, rainy, or snowy weather and moderate to high temperatures are the accompaniment of Lows, while clear and cool to very cold weather accompanies Highs. There are exceptions to both of these assertions, but they are not many. Now, a striking feature of these pressure areas lies in the variation of their respective intensities as revealed by the arrangement of their *Isobars*. An isobar is a line which passes through all points having the same atmospheric pressure, i.e., through all points where the barometer reads the same. The isobars tend toward a concentric arrangement. In an ideal pressure center they would be absolutely concentric. Irregularities in their course may be due to many reasons, such as temperature differences, variations in moisture content of the air, topography, and so on.

DO WEATHER CONDITIONS INFLUENCE RADIO RECEPTION?

IT OCCURRED to the writer when he heard statements referring to the weather and radio reception, such as are quoted at the beginning of this discussion, that their logic was frequently faulty. It seemed that with broadcasting and receiving stations oftentimes 500 to 1000 miles apart, the local weather conditions at the receiving station could not have much influence on reception, unless the same conditions prevailed over all the country between the two stations. Such uniformity in weather is not common. Therefore, to ascribe poor receptivity to the local weather could not be an accurate analysis. Furthermore, it was true that occasionally



A TYPICAL WEATHER MAP OF THE UNITED STATES

Which shows clearly the alternating "Highs" and "Lows." According to the theory advanced by the author, radio reception in a low pressure area tends to be somewhat weaker than in a high pressure zone of corresponding intensity

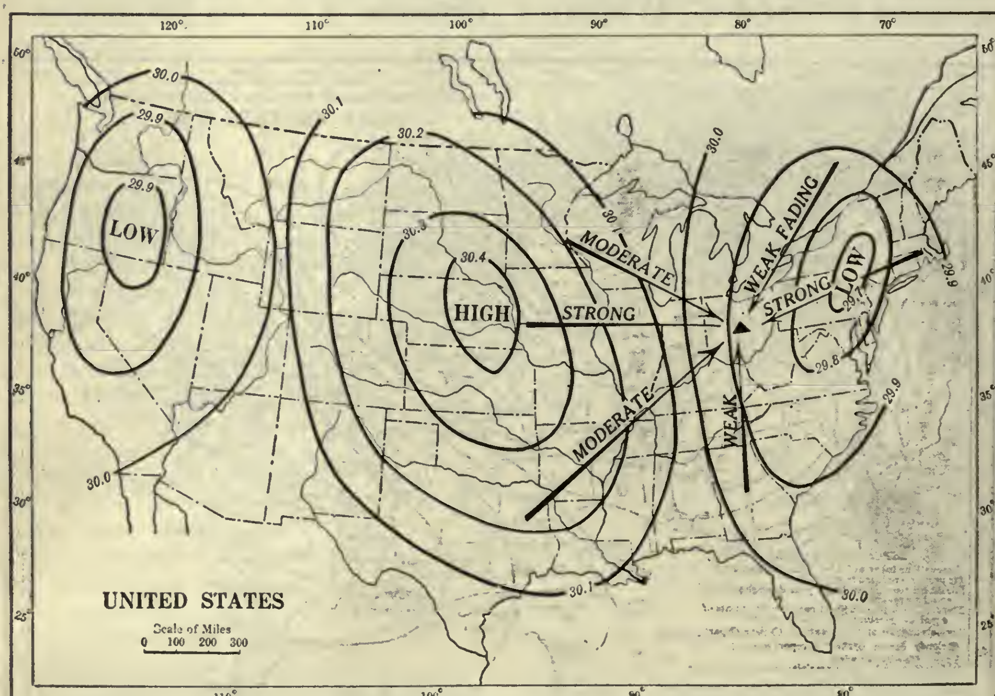
when the weather was "bad," reception was good, although the association of the two facts at such times was entirely overlooked. It seems to be a common trait among most of us to analyze and criticise rather thoroughly when things go wrong but to take matters for granted when we are enjoying results which seem to us to be wholly normal.

The situation just noted led to an investigation, which has thus far revealed some striking conclusions. It seems that since broadcasting involves the transmission of electromagnetic waves, a wave motion transverse in type, there might be a definite relation between such transmission and the circulation of air in High and Low pressures. Observations were made to determine whether any such relationship might exist, or whether there could be a relation between the strength and clarity of reception, and the arrangement of isobars.

NEW THEORIES FOR RADIO CONDITIONS

A FIVE-tube neutrodyne set was used, with an outside antenna about 125 feet long, and about 30 feet from the ground. The direction of the antenna was almost exactly northeast-southwest. The observations follow:—

1. If a line connecting the receiving station with the broadcasting station crosses the intervening isobars at right angles, reception is at its best.
2. The steeper the isobaric gradient (that is, the closer the isobars to each other) the stronger the reception.
3. The more nearly the transmitted waves approach parallelism with the isobars, the weaker the reception. Under these conditions, fading occurs.
4. Reception in a Low pressure area tends to be somewhat weaker than in a High of corresponding intensity.
5. Reception is weaker when the transmitted waves cross from one pressure area into another than when they travel only within one area.
6. The strength of reception for any station is a factor of both its location within a pressure area and its position with respect to the broadcasting station.
7. "Bad weather" does not affect reception, excepting as it may be the index of an unfavorable pressure distribution.



AN IDEAL WEATHER MAP

Drawn to show the relation of the strength and clarity of reception to the angle between the direction of transmission and the isobars. An isobar is a line which passes through all points whose barometric pressure is the same. The arrows on the map indicate the direction from which broadcast signals were received during one of the tests made at the author's station in Columbus, Ohio

8. Reception can be as good in "bad weather" as in good weather if the pressure distribution is right.
9. Temperature does not influence reception, excepting as it may be the index of pressure distribution as follows:—
    (a) Reception is better in winter than in summer because the cyclones and anti-cyclones are more intense in the winter period.
    (b) Reception is better when temperatures are low than when high, because low temperatures usually indicate intensive High pressure areas, that is, areas with steep isobaric gradients.
    (c) Low temperatures accompanying poorly defined High pressure areas make reception poor.
10. Shallow or flat pressure areas result in much static-noise in the receiver.

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THE NETHOSCOPE

Used by the Weather Bureau to aid in predicting the weather. Simplified, the apparatus is a black mirror and is used to determine the direction and velocity of clouds

HOW CONDITIONS CAN BE FORECAST

WITH the above observations well defined, the question which quite naturally arises is, Can the strength and clarity of reception be forecast? The answer is, "Yes!" It can be forecast with the same degree of accuracy as the weather, but hardly with any greater degree. Forecasting the weather depends upon a knowledge of the movements of cyclones and anti-cyclones and their peculiarities in various seasons of the year. Forecasting radio reception, assuming no interference by regenerative sets or the like, is dependent likewise upon a knowledge of the movements of the same pressure areas. However it involves not the forecasting of the probable state of the weather at the station concerned, but only the prognostication of the arrangement of the isobars between the respective receiving and broadcasting stations, and the probable steepness of the isobaric gradients.

By such forecasts, much may be saved to the people. One may know the futility of trying to get certain stations on given nights and save power, time and nervous energy. Sets may not be blamed for poor service when pressure conditions are the cause; and broadcasters may not be criticised for failure to speak plainly or loudly enough, or in general because of lack of efficiency,

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WEATHER FORECASTING APPARATUS

According to the results of the experiments of the author, when weather conditions are accurately known and compared with radio transmission and reception phenomena, it is probable that much may be discovered about the mysteries of freak radio signals. The device shown in the photograph records the direction and velocity of the wind

when as a matter of fact they are performing properly and well.

Another phase to this problem, not yet worked out, involves the relation between the power required to send the waves and a possible adjustment with respect to the atmospheric pressure. We know there is some relation to sunshine, for during the daytime one can not receive over great distances, unless the sky is clouded the entire distance. So there may be a correspondence between the wave motion itself and the air pressure, which if learned, would reduce the amount of power required for wave transmission and perhaps in still other ways wholly revolutionize broadcasting.

OBSERVATIONS ON THE RADIO LIFE: NO. 2

California on the loud speaker

The Meaning of the ★

PRIMARILY the star of approval, which appears in Radio Broadcast advertising, means "Approved by Radio Broadcast Laboratory." Although this certification means a great deal to those advertisers whose copy bears this mark of approval, it does not necessarily discriminate against the copy not so marked.

In placing this sign of approval in our advertising pages, several issues are considered. It is far from humanly possible for us to test each item advertised by every manufacturer and still do the great amount of development work which has proved so valuable to our readers. Where we have sufficient knowledge of a manufacturer's products and his business standing, we place our Star on his copy with the assurance that, if the customer is not satisfied, the manufacturer will refund his money. In case a manufacturer develops a questionable device we always request that samples be submitted for our inspection. Advertisers with whose products we are not thoroughly familiar are required to submit samples before receiving the Star.

The meaning of the Star however, is not thus limited, for, added to the approval, which is advantageous to the manufacturers, we are not overlooking the prospective customers. A reader seeing the Star should not necessarily draw the inference that here is a product better than any other. It does, however, mean to the reader that he will either get satisfaction or his money back. In placing the Star in advertising, we are assuring the reader of our confidence in these manufacturers. The omission of the Star indicates that we have not had the opportunity to become thoroughly familiar with the products advertised. The fact that advertising appears in our pages at all indicates that we consider it reliable.

In placing our approval on apparatus submitted for test we have no intention of causing friction by unfair discrimination. Our approval does not in any way indicate that we assume that the products of those advertisers are perfect. What it does mean is that the manufacturer has satisfactorily met the claims he is making for such apparatus and that he supports his claims with a "money-back" guarantee. In passing on the apparatus in this manner, we must necessarily take its selling price into consideration and so the Star is an assurance that one will get full value on his investment.

"Approved by Radio Broadcast Laboratory" gives the purchaser assurance that he is buying the product of a reliable manufacturer and that he can in this way feel certain of getting reasonably satisfactory results. Its purpose is to boost the legitimate and honest manufacturer. It is our intention to extend our present plans to the point where Radio Broadcast will carry no advertising where the apparatus has not actually been tested in our laboratory.

How to Solder

BY WILLIAM F. CROSBY

TO THE uninitiated, the art of soldering appears to be something which only the most expert workman can do. It appears to be a talent which the novice can hope to acquire only with years of practise. It may be an art, but it is an easy art, and one which even some of the most inexpert of our radio builders have conquered, to the great improvement of the sets they build.

There is just one fundamental rule in successful soldering, and that is cleanliness. This does not necessarily mean that the man doing the work must have on a clean collar and his hands must be manicured; but it does mean that he must see that the soldering iron has a clean collar of solder and that the surfaces to be soldered are manicured.

Seriously, though, soldering is easy, once the importance of having everything clean is realized. Solder will positively not stick to a surface which is oily or corroded. If one part is clean and the other dirty, the solder will stick to the clean surface but not to the dirty. If you do not believe this just try it and see. Fully half of those who have trouble with soldering because the surfaces will not stick, or the solder drops off, have not realized that a clean surface is the first essential.

RADIO BROADCAST Photograph

FIG. I

The soldering iron should always be shinily clean. The burned coating which collects on the working surface of a gas iron can be removed with a flat file as shown in the photograph. When using the file, the solderer should push it away from him and lift the file from the surface on the return motion

The next step is the consideration of the soldering iron itself. Many constructors are using gas heated irons with varying degrees of success, but once let a man use an electric soldering iron and he will never make further use of the gas range. These irons may be secured in many sizes and shapes and some of them have interchangeable points. With this type of iron it is possible to secure a fine point for small work, a curved point for the inaccessible places or a blunt, heavy point for the work which is more in the open. The writer is of the opinion that the fine pointed iron is the best for all around radio work. It is satisfactory for coarse soldering and also for the finer work and if a little care is exercised in wiring the set, there is no reason why every connection cannot be reached. Of course the inside wires should be placed first and the work carried on so that the outermost wires come last.

"TINNING" THE IRON

GENERALLY a new soldering iron is not "tinned." In other words the surface is coppery all over and, in passing, it might be just as well to point out that soldering "irons" are not iron at all but "copper," for it seems to conduct and hold the heat better.

Now suppose we want to "tin" a new iron. The first thing to do, of course, is to get it hot, not red hot, and not cherry red either. Usually a good test is to have a small can of soldering paste handy and dip the point of the iron in this from time to time. When the iron is sufficiently hot, the paste will sputter in a good lively fashion and after a little experience you will be able to tell at just what point the soldering is easiest.

Assuming that the iron is properly heated the next step is to plunge the end briefly into the can of soldering paste. Before this is entirely burned off, solder should be applied to the end of the iron and then rubbed over the point with a soft rag. It is surprising to observe the ease with which this is made to adhere, provided, of course, the point is clean. The whole end of the iron should be treated in this manner until it is tinned completely. Make sure that the rag is doubled back and forth several times so that

Radio Broadcast Photograph

FIG. 2

Rubbing the working top of the iron on a piece of sal ammoniac removes the oxide coating and prepares it for tinning. The iron must be quite hot and the surface of the sal ammoniac must be clean

your hand will not come into contact with the hot iron. This rag should be kept handy at all times and when doing extensive soldering, the point should be wiped clean occasionally. It may also be necessary to re-tin the point if the iron has become too hot at any time. When this is done, it is first necessary to scrape the point with a file so that the shiny copper is again exposed. The rest of the procedure is then followed as outlined before.

Radio Broadcast Photograph

FIG. 3

Applying the strip solder to the cleaned tip of the iron. The solder should quickly take to the iron after it has been properly cleaned

WHAT SOLDER TO USE

THERE are many different kinds of solder on the market, but it is generally conceded among radio men that good resin core solder is the best for all around work. This is excellent if used with a small amount of soldering paste and you can make up a joint which will last for years.

Acid core solder is completely out of place as far as radio is concerned. The acid will attack the copper and cause quick corrosion with consequent noise in the set. Of course plain wire solder is excellent, but it will be necessary to use a little more paste with it.

The paste consists of a resinous material of a pasty consistency which helps to make the solder stick by acting as a cleaning agent.

Radio Broadcast Photograph

FIG. 4

A good soldering outfit. From left to right: liquid soldering flux, paste flux, flat nose pliers, electric iron, sal ammoniac, and strip solder

There are many forms of this material some of which are liquid in form. It is never advisable to use too much of any of these materials, because all of them will cause trouble if applied in this manner.

The customary thing is to have a match handy, and with this dip out just a tiny bit of the paste and apply it to both surfaces to be soldered. A little solder is then applied to the end of the hot iron, the two surfaces placed together, and the solder applied. Make sure that the surfaces are held tightly together until the solder has had a chance to cool. This is a matter of seconds only and before the joint becomes entirely cold, wipe it off with the rag used for cleaning the iron. This wiping off will remove surplus soldering paste or flux and prevent possible corrosion of the joint.

Remember that a tiny drop of the solder

RADIO BROADCAST Photograph

FIG. 5

Wiping the iron to keep it bright. A clean iron means good work. Any old cloth may be used to wipe the iron

will do the work better than a big crystal-like lump. The solder should be hot enough to flow evenly almost like water. The surface of a correctly soldered joint should be smooth with only enough solder to hold the joint together. Wiping it off as suggested, will do much to improve the appearance.

A PRACTICAL EXAMPLE OF A SOLDERING PROBLEM

LET us actually solder a joint. We will make a connection between a new piece of bus bar and an old soldering lug on a variable condenser. This condenser happens to be mounted on a panel in the usual manner.

The first thing to do is to place the iron on to heat, either by plugging it in on the electric light socket or by placing it over the gas flame in the kitchen. While the iron is heating we get the rag, wire solder, and paste handy and then proceed to clean off the surfaces. The lug on the condenser is badly corroded and it will never hold solder. A small file or a bit of emery paper will help us here and the lug is soon shiny. It is also advisable to touch up the bus bar a little despite the fact that it is new. The grease on the hands will sometimes cause failure in a connection of this kind, especially if the wire has been handled a lot. A light scraping with a knife is sufficient to clean the bus bar.

The wire is now bent into place so that it touches the soldering lug on the condenser. If possible, arrange this in such a way that the wire rests in place by itself. This makes matters easier and takes the strain from the connection. Since solder, like water will not run up hill, it will be far easier to make this connection if we tilt the whole set forward so that the lug on the condenser is on top.

When the soldering iron is sufficiently hot, it is dipped for an instant in the paste. A bit of this paste is applied with the match to the bus bar and the lug. Next take the solder and hold it so that a small drop adheres to the surface of the iron. Apply the iron to the joint then and allow the solder to flow in smoothly around the wire and the lug. It is not necessary to cover the wire entirely as long as it is held securely. Put the iron back to heat, and by this time the joint should be hardened sufficiently to hold. The next step is to wipe it off with the rag. An excellent joint results.

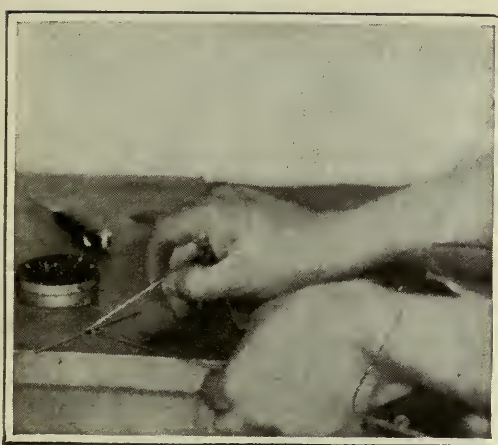
GENERAL ADVICE TO THE SOLDERER

REMEMBER that the solder is in a liquid form and if you handle the iron too quickly it will drop off and possibly burn you or your clothing. Remember also that copper and brass are good conductors of heat and if you handle the parts just soldered too soon, you may get a bad burn. Brass binding posts particularly, have a way of staying hot for a long time and some of the fixed condensers are veritable furnaces for holding the heat. In fact due to this alone, it is far better to make a connection through a fixed condenser with a small machine screw rather than soldering the

RADIO BROADCAST Photograph

FIG. 6

Re-tinning the iron. A small can cover containing a portion of melted solder and paste flux may be employed for periodically re-tinning the iron. The flux cleans the soldering iron surface so that the solder in the can cover will adhere to it



RADIO BROADCAST Photograph

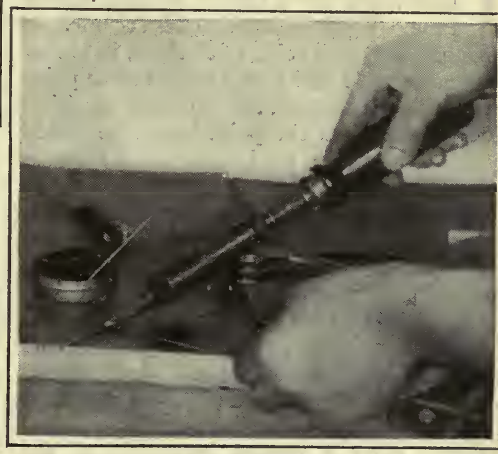
FIG. 7

How to prepare a joint for soldering. A bit of flux is applied, with the aid of a stick or scrap piece of bus bar, to the joint to be soldered. This flux cleanses both wires so that the solder will stick to them

wire to it. Many fixed condensers have actually been short circuited by the soldering process.

Do not think that because every joint is soldered, the set cannot have a loose connection, because this happens far too often. Sometimes too much paste applied to a joint will cause a layer of this material to harden in between the two surfaces. Naturally such a condition will make the set very noisy. In another case the writer found a set in which a soldered connection had completely parted due to the fact that the wires had been under too much tension when soldered. This joint had pulled apart during the set owner's absence, and it was only after several evenings of frantic effort that the trouble was finally located in one of the most inaccessible parts of the set.

To sum up the whole art of soldering, the "artist" must remember just two things. Keep the soldering iron clean and the surfaces *clean*. This is the whole secret of the thing.



RADIO BROADCAST Photograph

FIG. 8

The iron should be held firmly on the joint to be soldered, touching both pieces so that when they become heated, the solder on the tip of the iron will flow evenly over the point. Additional solder may be fed from the strip solder wire or it may be "picked up" from the can cover

Latest Alterations in Broadcasting Wavelengths

COMPLETING the list of Class B broadcasting stations whose wavelengths have been realloted by the Radio Service, Department of Commerce, the following Pacific Coast stations received new wavelength assignments:

KNX	Los Angeles, Calif.	336.9 meters
KFAE	Pullman, Wash.	348.6
KGO	Oakland, Calif.	361.2
KFOA	Seattle, Wash.	384.4
KHJ	Los Angeles, Calif.	405.2
KPO	San Francisco, Calif.	420.3
KFI	Los Angeles, Calif.	468.5
KGW	Portland, Ore.	491.5
KIX	Oakland, Calif.	508.2

Wavelengths assigned to points where broadcasting stations are to be erected were:

Corvallis, Ore., 280.2 meters, Los Angeles, 293.9, Phoenix, Ariz., 299.8, Seattle, Wash., 305.9, Pasadena, Cal., 315.6; Salt Lake City, 333.1; Missoula, Mont., 394.5, and Seattle, 454.3.

It was recently announced in a news dispatch from Washington that the Radio Service was considering readjusting the entire wavelength assignments now in force with Class B stations. This would be done in order to give each station a separation of fifteen kilocycles instead of ten, as is now the case. It is not now known when that reassignment will take place.

The Revelations of Enoch

The Short-Wave Doodlebug—Pocket Humor and Radio Philosophy Uttered by a New Electro-Optical Discovery

BY W. R. BRADFORD

IN THE baseboard that runs around the floor of my studio, and radio lab. is a hole made by a mouse at some earlier time. The hole at present is occupied by a Doodlebug, who holds forth there, in bachelor quarters. I had gone to quite some pains in making friends with this little fellow, and at last succeeded to the point where he would poke his head from the hole and look me over carefully with his beady, black little eyes.

As we became better acquainted, I began to take liberties. One day I held forth a finger for his inspection, and the little cuss mounted my finger, whereupon, I lifted him to my desk, where reposed a Knockout Roberts set. The Doodlebug gazed at the set and began to show interest.

I made a little ladder and placed it against the panel. The Doodlebug climbed the ladder! After a careful inspection of the set, he turned and waved his antenna in a peculiar, jerky manner. Getting no response, he repeated this several times. Suddenly I discovered he was wigwagging me, in the International code!

"Make a short wave set," said the Doodlebug: "I want to talk to you!"

"What wavelength shall I make it?" I wigwagged back.

"Make it one half of one per cent." said the Doodlebug.

"THE LITTLE CUSS MOUNTED MY FINGER . . ."

Alas! My lab contained no equipment to comply with this Volsteadian requirement: "Talk with me in wigwag," I signalled: "Later on I shall make a set."

The Doodlebug pulled down his vest, metaphorically speaking, and wigwagged the following:

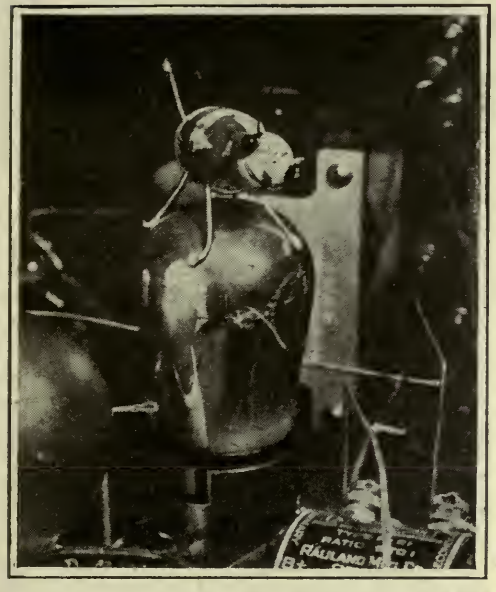
NEW RADIO PHILOSOPHY

RADIO is nothing new to me. I was born with it, as all of the insect family are. Few of the insects have vocal cords, so we de-

ENOCH TESTING A GRID CONDENSER
And putting the hall mark of approval on it

pend on radio for our communication. No, we have no understanding of the sign language, such as your mutes use, though our different postures and actions indicate our feelings and desires, in a more or less crude manner. But our main means of communication is by radio. Our waves are similar to those you use, but very much shorter. Man may some day be able to communicate with us when he understands our units of measurement, which are minute, compared to your methods.

"We do not receive and send by your methods. What you would call nerves, are all arranged for, in our antenna, our segmented organs of sensation. You depend on sound. We feel vibrations. Though these vibrations are minute, we can receive and send them a considerable distance—as much as two hundred feet. No, we are not bothered with



IT'S A WISE BUG

That knows its own receiver. Enoch, the confidential radio bug, is photographed in a moment of his marked preference for the Roberts Knockout set

static, or extraneous interference. We have no 'squeal hounds' to make our radio a thing to swear at. There is no 'best circuit' with us. Each one of us is his own super-heterodyne, so to speak. Thus, much valuable time is saved, which would otherwise be wasted in endless wrangling over 'low loss apparatus,' and such flubdub!"

(Did you ever hear the likes of that? The very kernel of good, sound radio sense!)

The Doodlebug continued: "Maybe you doubt me? Well, the ignorant ever condem that which they do not understand."

(Get that? That little jasper has read Rochefoucauld's *Maxims*, I betchuh!)

The Doodlebug waved on: "An ant finds an open sugar bowl. He is not like a human —greedy, and wanting all for himself. No. He is one of God's creatures who share with others—at least, with their own kind. Does he waste valuable time running wildly around, shouting: 'Oi, yoi, yoi! Come and get a mouthful of sugar'? No. He broadcasts the news with his own little station—his nerves, and his antenna. Each ant's sensory apparatus, his antenna, is tuned to the same wavelength, which never varies. All the ants within range of his broadcast come and tune into the feast—until one of you humans turn loose with a howitzer loaded with insect powder."

(So that was the way ants learned of sugar banquets! Come to think of it, it must be so. One time an ant crawled down my back— and took his broadcasting station with him. Inside of two minutes, a string of ants had begun to crawl up my trouser leg! I'll wager the explorer ant got lonesome, and broadcast for company!)

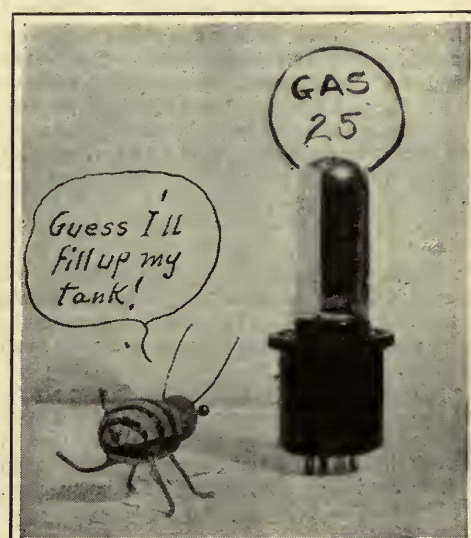
Just then Mrs. Betterhalf called: "The furnace needs attention!" Quick as a flash the Doodlebug ran down the ladder and made for his hole in the baseboard.

Bachelor Doodlebug? Such actions denote fear of the feminine, and indicate that this little rascal at some time had some unpleasant matrimonial mélange. (I fear the plot is going to thicken somewhere.)

His actions brought to mind those of a comic character of mine, so I named him Enoch. Enoch, you remember was afraid of his wife.

I shall make a short-wave set. The shorter the better, evidently. Then in our next interview we may learn more about short-wave radio—and other things. We shall see.

(As Enoch hurried to his hole, I pot-shotted him with my faithful camera. Doesn't it make a nice little tail piece, for a story finish? Thanks. I thought you'd like it.)



"NOW, I HAVE FOUND . . . . . ."

A Department Where Readers Can Exchange Ideas and Suggestions of Value to the Radio Constructor and Operator

ALTERNATING CURRENT AS A SOURCE OF FILAMENT SUPPLY

RECENTLY I have been experimenting with alternating current as a means of heating the filaments of vacuum tubes. The idea is, of course, an old one, but for some reason has never been put into practice to any great extent. Alternating current cannot be used satisfactorily to heat a detector tube filament. This article will be confined to a discussion of the use of alternating current in amplifiers.

With the advent of the dry cell tube our troubles concerning filament supply would seem to be ended. However, these small tubes are so designed that they are unable to handle much power and hence are not very satisfactory as audio-frequency amplifiers, especially in the second stage. For tubes requiring more than .25 ampere filament current, dry cells are uneconomical.

The difficulty to be overcome when alternating current is used, is the hum which is produced in two ways:

1. If the grid return be connected to either end of the filament, then the grid potential becomes alternately positive and negative with respect to the midpoint of the filament. If it were possible to connect the grid return to the midpoint of the filament, then, of course, its potential would not change. This cannot be done but a trick may be employed which by means of a potentiometer, as shown in Fig. 1, the same results may be produced. Here we see that the midpoint of the potentiometer remains at constant potential, namely, the same potential as the filament midpoint. Hence, by adjusting the potentiometer we can make the grid return remain at this same potential. This simple adjustment is easily made and the hum reduced to a very small quantity.
2. The temperature of the filaments does not remain constant, but changes continually from a maximum value to a minimum value as the current through the filament passes through its cycle.—zero, positive maximum, zero, negative maximum, zero. See Fig. 2.

For the usual house lighting supply, the frequency is 60 cycles per second. The filament temperature, therefore, reaches its maximum and minimum temperatures 120 times per second. This produces an audible hum in the phones at a frequency of 120 vibrations per second. It is interesting to check this value against the tone of B below middle on a properly tuned piano. If middle C is 256 vibrations per second, then B, an octave below, is about 123 vibrations per second. By listening to the hum produced in the phones when the potentiometer arm is properly adjusted for constant grid potential, and comparing this hum to B below middle C, we cannot detect the three cycles difference.

If the potentiometer arm be moved so that the grid return is connected to one end of the filament, instead of midway between its two ends, then the grid potential varies with respect to the filament at the rate of 60 cycles per second. This, of course, causes a 60 cycle hum in the phones in the plate circuit. If we actually move the potentiometer arm away from its mid position and at the same time listen in the phones, we hear the 120 cycle hum gradually become lost in the 60 cycle hum, as the latter increases in amplitude the further we move the potentiometer arm from its midpoint.

Well, all this theory sounds very fine, but what good is it? In answer to this I shall describe briefly a single-stage audio-frequency amplifier which I have constructed employing the potentiometer feature as outlined, and find entirely satisfactory from every standpoint. The quality of reproduction is good, the volume is ample, and there is *no* noticeable a. c. hum. The loud speaker which I am using is merely a fibre megaphone about 2 feet long with a wye victrola headset connector soldered to it, and a pair of Western Electric phones. The quality of reproduction is better than many loud speakers now on the market.

Now for the amplifier itself. The apparatus required:

An audio-frequency amplifying transformer.
Rheostat, tubes, socket.
Potentiometer (200 ohms or more).

The apparatus is assembled in a manner similar to the usual audio-frequency amplifier. The rheostat *must* be placed between the

potentiometer and the a. c. supply as shown. See Fig. 3.

I am using this amplifier in conjunction with a one-tube reflex set. This tube is a UV–199, and its filament supply consists of three dry cells in series. The proper negative grid bias for the audio amplifier tube may be obtained either from a separate C battery, or, by connecting the A battery of the first tube so that it acts as C battery for the second. This is shown in Fig. 3.

The value of C battery which will give undistorted amplification depends upon the type of tube used and also upon the plate voltage. For 200 and 300 tubes, use about 1.5 volts. For 201–A and 301–A tubes use 1.5 volts for a plate voltage of 40 volts, and 4.5 volts for a plate voltage of 90 volts.

The a. c. supply for filament must of course be transformed from 110 volts to a lower value. This is most economically done by means of a toy transformer which can be purchased for a couple of dollars. The secondary voltage may be from 5 to 10 volts. Most storage battery tubes are designed to operate at a filament voltage of 5 volts. I am using a UV–200 tube, consuming a filament current of 1 ampere. The secondary of my transformer gives me 5 volts. The type of rheostat used depends upon the tube. In this circuit, a 6 ohm rheostat is used.

In order to find out the resistance of the rheostat necessary, first determine the normal filament voltage and current of your tube and the secondary voltage of your transformer. Subtract the filament voltage from the transformer voltage and divide by the current. This gives the value of normal resistance in series with filament. The rheostat should, to allow for discrepancies, have a somewhat higher resistance than this computed value, say 25 per cent. For example:

Given

Filament voltage—5 volts.
Filament current—$\frac{1}{4}$ ampere.
Transformer secondary voltage—8 volts.
8—5 volts = 3 volts.
$3 \div \frac{1}{4} = 12$ ohms.

Adding 25 per cent. we get 15 ohms as the resistance of the rheostat. It can be seen from the above that any value of transformer voltage may be used provided the rheostat resistance is properly computed.

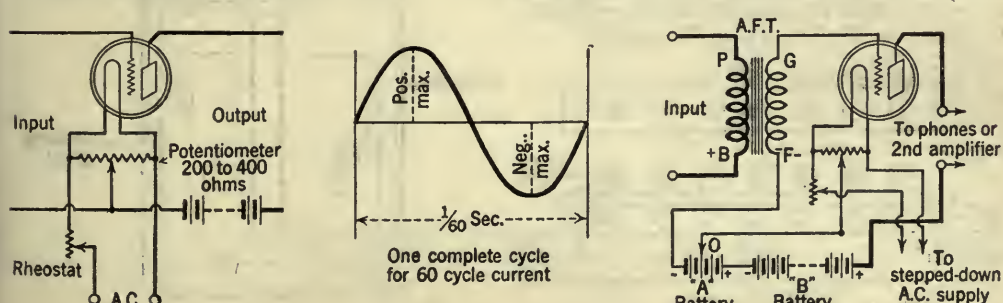
I use only one stage of amplification on my set because the resulting volume of signal is quite sufficient. However, there is no reason why two stages cannot be used, employing a common potentiometer and filament rheostat. The rheostat as determined for one stage may also be used for two stages.

Of course, the filament transformer may be constructed without much trouble, but its specifications will not be given here.

The audio amplifier using a storage battery may readily be converted to use a. c. merely by the addition of the potentiometer. The total initial cost of the a. c. amplifier is less than the usual method and its upkeep is less. Another point of some importance is the fact that tube filaments have a longer life when heated with a. c. than when d. c. is used.—J. B. CLOTHIER, JR., Lansdowne, Pennsylvania.

A SCREW STARTER

WHEN constructing radio sets it is often difficult to hold the screws so that they may be put in some nearly inaccessible place. An efficient device may be made by slotting a piece of quarter-inch brass rod about six inches long, with a hack saw, for about a half inch. In this slot two phosphor bronze strips about an inch and a quarter long are inserted and soldered in. The tips are then filed so that they will be thin enough to insert in the slots of small screws. They are then sprung so that their natural position is with the ends about an eighth of an inch apart. When these tips are pressed together and placed in the slot in the screw, and then re-



FIGS. 1, 2, AND 3

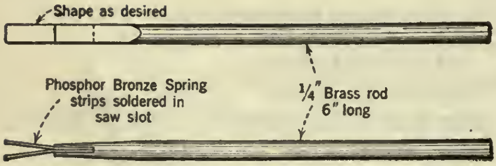


FIG. 4

leased, they will hold the screw securely until it has been started, and then it can be released by simply pulling. The sketch, Fig. 4, shows the details.

A CONVENIENT MOUNTING STRIP

A VERY practical method of installing a receiver is to bring all battery leads up through the top of the operating table, to binding posts mounted on a strip of bakelite which is fastened to the table top. Fig. 5 shows the details. This not only provides an exceptionally neat installation by keeping all wires and batteries out of the way, but will be found very advantageous whenever it is necessary to change from one receiver to another, or to test out any receiving set. The A battery and B battery posts are not connected in any way, due to the individual requirements of the various circuits, but these connections can be bridged across from one post to another, if such connections are not taken care of in the wiring of the receiver itself.

Short pieces of wire are run from the posts on the mounting strip, to the posts at the rear of the receiver, and when taking off one receiving set to try another, it is merely necessary to loosen the binding posts on the table, allowing the connecting wires to remain attached to the receiving set, and they will then be in proper position for re-connecting.

This method of bringing antenna, ground, and battery leads to a receiving set will immediately find favor with all experimenters who ever have occasion to disconnect one receiver to test out another circuit.—HARRY W. GILLIAM, Big Stone Gap, Virginia.

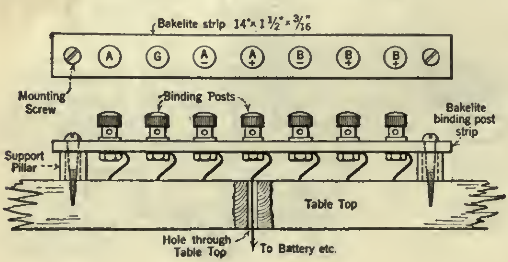


FIG. 5

A GOOD FILTER CONDENSER

NO DOUBT many readers were very much interested in the B battery from the lamp socket, as described by Mr. Le Bel in the September, 1924, RADIO BROADCAST. Perhaps they may also be interested in the following description of an electrolytic condenser for use in such an outfit.

The condensers built by the writer and used in this outfit were made as described below and as illustrated by the sketch, Fig. 6. Each condenser required one large mouthed glass jar, a hard rubber or wooden top, an aluminum sheet, a quarter inch diameter steel rod and an electrolyte of ammonium phosphate in pure water. The aluminum sheets used were four inches wide by five feet long and one sixty-fourth inch thick. A small tab or ear was left on each for making a connection. The sheets were rolled into a spiral as shown. The steel rod is for making contact with the solution.

After the parts are assembled and the solution poured into the glass jars, the plates must be formed by passing a current through the condensers. This may be done by connecting a 100 watt lamp in series with them and plugging the circuit into a lamp socket. It takes a long time to form the plates but it can be done with a little patience. When the

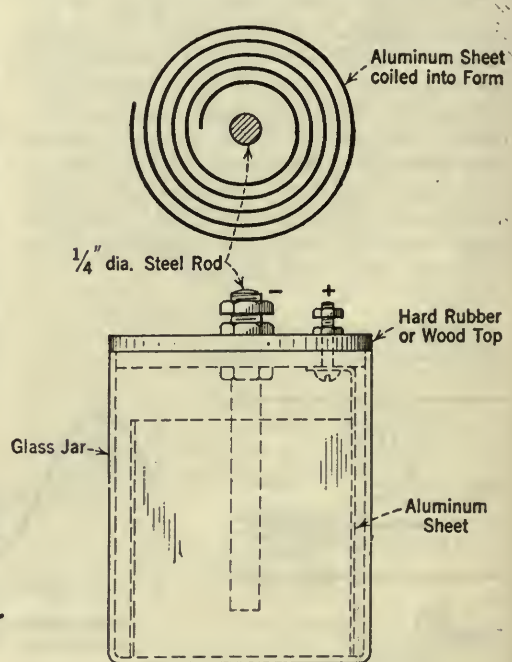


FIG. 6

forming is advanced far enough a good spark should occur when the condenser is short circuited after a charge.

A pair of these is now working very well in a lamp socket B battery outfit. The residual hum is small enough to be negligible and it seems to become less with use. This outfit is supplying the plate potential for a Roberts Knockout circuit in very satisfactory fashion. —C. E. Seifert, Cincinnati, Ohio.

MAKING YOUR OWN CABINET

The average amateur makes a very poor job of his cabinet, which spoils the appearance of an otherwise good receiver. The following is a description of how to make it look like a factory job with a piano finish, without the use of a lot of clamps.

It is possible even to use an old walnut sewing machine top for the wood. The general specifications are outlined in Fig. 7.

The joint at "a" is glued, but clamps are not required to hold it. It is sawed as in "b." First use a marking gauge, place a back on the line to keep the saw straight, or use a mitre box if one is available. Next use a chisel on the end to cut it out.

Then bore three holes in each side piece for round headed brass screws as at "a," place the back of the case in a check and mark the holes through; but when drilling allow a little draught to draw pieces up tight, as in C.

This will bring the pieces up tight when glue and screws are applied so that the joint will not show. The bottom moulding is in two pieces. The top bead is a strip $\frac{1}{4}$ x $1\frac{1}{4}$ inches with outside edge rounded and corner mitred shown at "b."

The base "c" is moulded with two chisels: one is a core box gouge, and the other a plain flat chisel. This is quite easy to do. When finished, scrape and sandpaper. The top bead "b" is then glued to the base "c."

After the case is together, get a bottle of white shellac and a small sponge. Apply three coats with the sponge, one right after the other as soon as dry. Allow about twenty minutes between coats. Then have a small piece of cotton batting tied up in a piece of woolen rag, wet this in alcohol and rub all over the case well. Now go all over the case with a piece

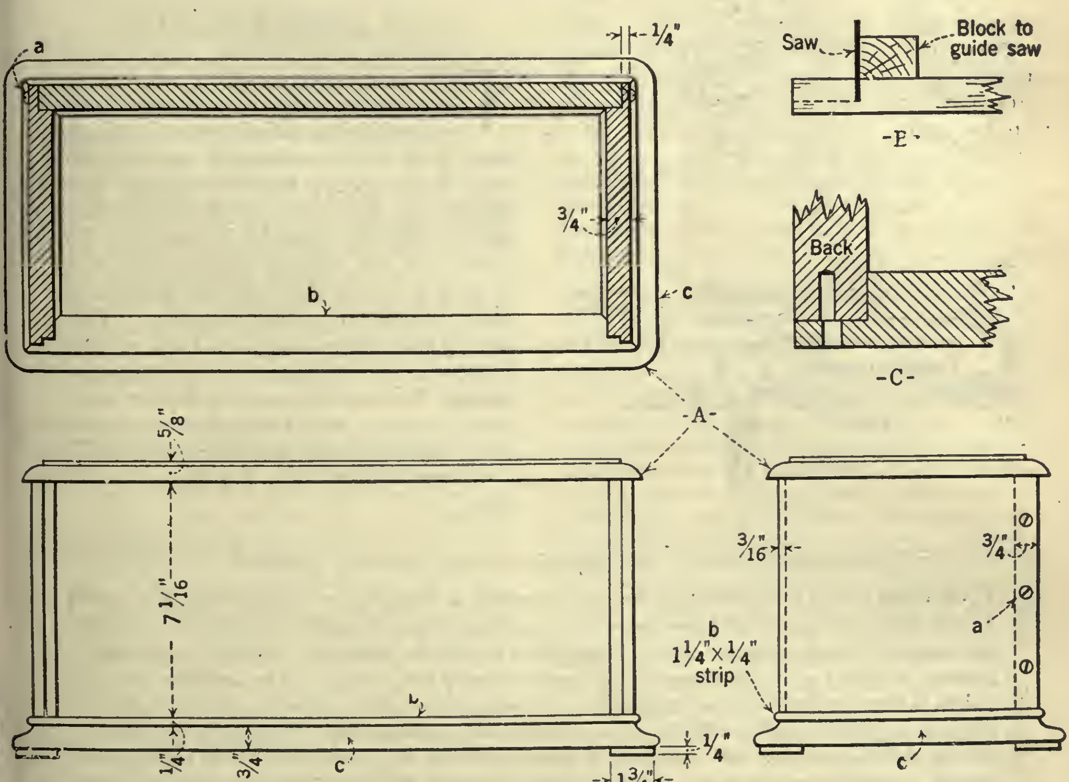


FIG. 7

of tallow, then dust on rotten stone from a woolen bag and rub well with the heel of the hand and a clean rag. The more you rub the better the finish. Try it and see; the finish will look like a piano, provided the wood is smooth when you start.—WELSFORD A. WEST, Hopewell, Nova Scotia.

A TICKLER KINK FOR THE ROBERTS

AFTER trying every conceivable way of working the tickler for my Roberts set, I have devised the scheme shown in Fig. 8. I have found it more satisfactory mechanically and electrically than the factory-made apparatus.

This arrangement cost me thirty cents (not including coils). It is made from the hardware of a 180° coupler bought at a five and ten cent store.

As will be seen, the tickler coil is brought into the field of the S_2 coil very gradually by turning the dial.

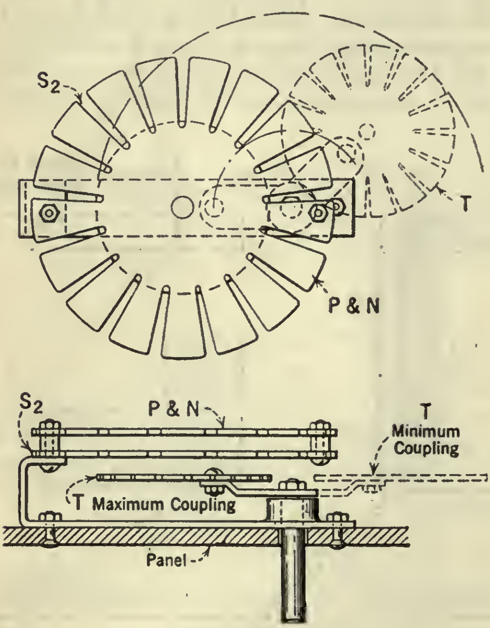


FIG. 8

Another feature is the small amount of space required behind the panel; it is about 2½ inches.

The coils are wound on standard forms, the T coil being cut smaller than the others.—J. BELL, Ottawa, Canada.

WHEN WORKING BAKELITE

TO SQUARE up the edges of bakelite, a common wood plane may be used if it is set rather finely.

An excellent and rather unusual finish may be given bakelite by inserting in the chuck of a drill press, a piece of wood about ¾ inch in diameter, and bringing this down on the surface of the bakelite so that the circles produced will overlap slightly. The finish is similar to that given the armor plate of safes, and when done evenly, gives a very pretty effect. It is best to practice on the wrong side of the piece or on a scrap piece until the knack is acquired.—CARL PENTHER, Oakland, California.

DULL FINISH FOR PANELS

THE instructions usually given for removing the gloss finish from bakelite, formica, or condensite panels, are to rub them down with No. 0 sandpaper and oil. However, in practice I have found that a very smooth yet dull finish, with no scratches, is more easily obtained by rubbing the panel down with No. 00 steel wool, dry. Oil may be used with the steel wool, or applied afterward, but is not at all necessary. The direction of rubbing should be back and forth, lengthwise with the panel. After the panel is rubbed down in this way, it is very easy to mark locations on it with a sharp lead pencil, when laying it off preparatory to drilling.—HARRY W. GILLIAM, Big Stone Gap, Virginia.

FOR a long time, RADIO BROADCAST has felt the need of an outlet for the many excellent ideas dealing with various features of radio construction which reach our office. If you have an idea about a valuable and useful new circuit, some new device, a construction or operating suggestion, we should like to have it. Payment of from two to ten dollars will be made for every idea accepted. The description should be limited to three hundred words and typewritten. Accompanying sketches, drawings, and circuit diagrams should be as plain as possible. We do not want simple, obvious suggestions. Material to be acceptable for this department must offer something of definite value to the constructor. Mere novelty is not desired. Address your manuscripts to this department, RADIO BROADCAST, Garden City, New York.

See Important Special Announcement on Page 112

QUERIES ANSWERED

How may I use a voltmeter and milliammeter in a Radiola super-heterodyne circuit?
C. J. M.—Pittsburgh, Pennsylvania.

I wish to add a stage of R. F. amplification to my regenerative receiver. How shall I do it?
W. D. M.—Worcester, Massachusetts.

Where may I obtain a college correspondence course in radio?
L. G. B.—Wilkes-Barre, Pennsylvania.

Will you publish a circuit diagram showing how to use straight audio, push-pull, or resistance-coupled amplification with the two-tube Roberts circuit?
K. H.—Burlington, Vermont.

I have become confused with the markings on audio-frequency transformers. Will you explain the proper markings and connections?
B. W. E.—Roanoke, Virginia.

Have you any other additional notes on the Roberts circuit?
C. T. S.—El Paso, Texas.

METERS AND B BATTERIES

HERE again we discuss the specific problem of the use and aid of meters in the B battery circuit of a Radiola super-heterodyne to determine the state of life of these batteries.

A milliammeter (0—100 milliampere scale) when placed in the circuits as shown in Fig. 1, A-B-C and D registers the drain upon the B batteries in milliamperes. This meter itself does not consume any of the energy as it is of low resistance. It may be permanently included in the circuit.

The full B battery drain will be indicated when the meter is connected in the terminal as in D, because this is the common return lead of the battery for both 45 and 90 volt terminals. In C only the 45 volt drain would be indicated, and in B only the amplifier drain would be manifest.

The voltmeter (with a scale reading from 0 to 150 volts) is used to indicate the state of voltage of the B battery. When voltage tests are made, the terminal leads of the meter should only be momentarily touched to the B battery.

The resistance of a voltmeter is such that a leakage path would be provided for the B battery current, and would soon discharge the battery, making it inoperative. Therefore it is not well to connect the voltmeter permanently across the B battery terminals. A switch may be provided which will connect it in the circuit for momentary readings.

The milliammeter and voltmeter afford all definite check on the life and condition of the B batteries and should be included in all installations, especially where many tubes are employed.

ADDING R. F. AMPLIFICATION TO REGENERATIVE RECEIVERS

A METHOD for adding radio frequency amplification to a regenerative receiver was discussed in the March, and May, 1924, Radio Broadcast, but as these issues are out of stock at Doubleday, Page & Co., the subject will be briefly treated here.

The problem to be considered in an addition of this kind is to construct an amplifier which will not radiate of itself into the antenna or pass along the oscillations of the regenerating detector.

The coupler T-1, in Fig. 2, is of the standard type, a primary with a secondary of about 50 turns shunted by a .0005 mfd. variable condenser. The primary may be variably coupled to the secondary. A tube socket, rheostat, .002 mfd. fixed condenser and 200 ohm resistance is all that is otherwise necessary.

The primary of the regenerative receiver serves as the plate coil of the amplifier. Radiation is prevented by the use of the 200 ohm resistance, which may be termed a losser, in series with the high voltage lead of the B battery supply.

Fig. 3 shows the Roberts form of amplifier which is highly recommended. Here, the plate coil of the amplifier must be specially wound with a pair of wires. The inside lead of one coil connects to the grid of the tube through a neutralizing condenser, and the outside lead of the other coil connects to the plate. The remaining two leads are connected together and thence connected to the high voltage B battery lead. The antenna coupler is of the standard type.

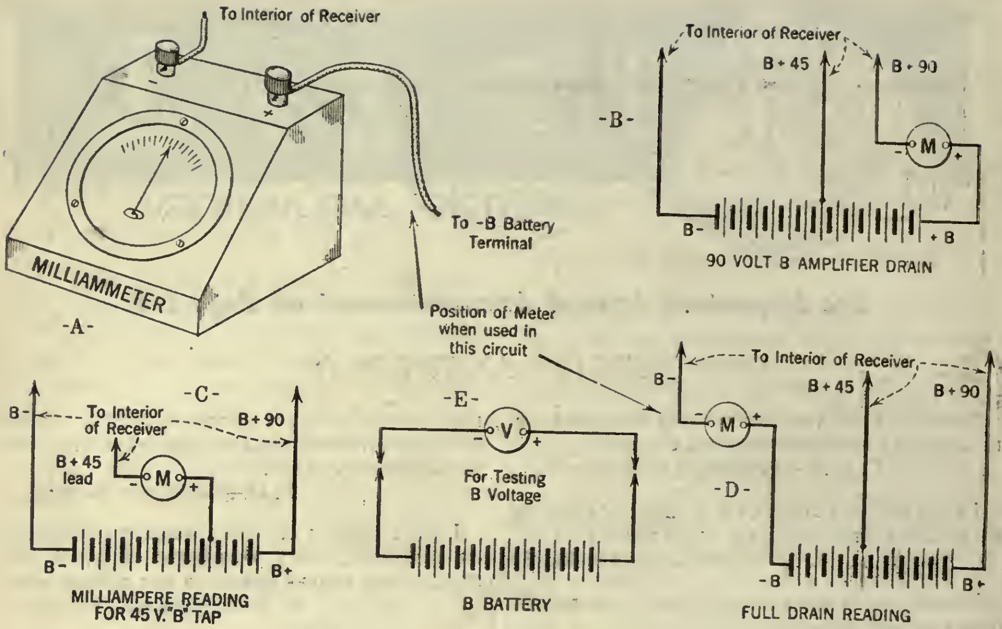


FIG. 1

COLLEGE RADIO CORRESPONDENCE COURSES

INTENDING in no way to discriminate, this department can advise that for those wishing to further their radio studies the course as outlined by the prospectus of the Department of Engineering of the Pennsylvania State College, State College, Pennsylvania, is especially interesting.

Two courses are provided, one, elementary, covering the principles of radio electricity—how telephone, crystal, and vacuum tube sets work—amplification, etc.—working drawings for eight typical receivers—discussions on topics such as static, directional effects, radio-photography, test methods, etc. This course is of ten assignments and costs $10.00.

The advanced course is also in ten assignments and the price is $15.00. It applies to technical men and amateurs, desiring the mathematical treatment of the subject, together with the electrical theory involved. It covers elementary electricity, radio circuits, electromagnetic waves, damped wave transmission, the electron tube, apparatus for reception, the tube as a generator, radio telephony, etc.

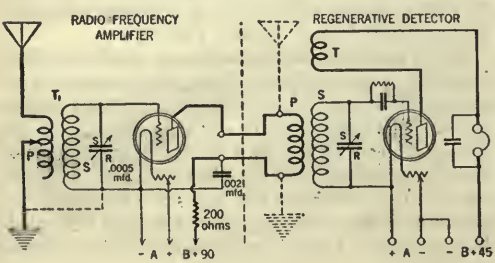


FIG. 2

AUDIO AMPLIFIER CIRCUITS FOR THE ROBERTS RECEIVER

IT IS to be remembered that the original two-tube Roberts circuit already contains one stage of audio-frequency amplification in the reflexed first tube. Now, in the addition of amplifiers the following has been determined:

1. The standard straight stage of audio usually

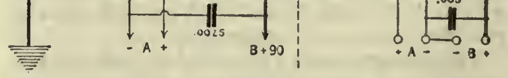


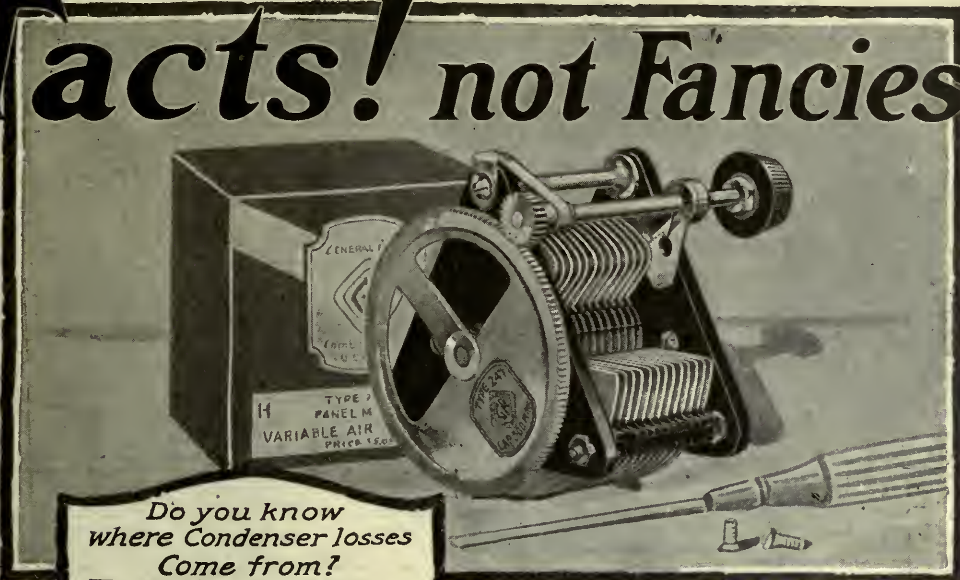
FIG. 3

overloads and causes distortion unless the transformer secondary is shunted by a variable resistance of a value of 10,000 to 100,000 ohms. The full amplification factor of the stage is not realized because of the inclusion of this "losser".

2. The push-pull amplifier is admirably suited for controlling the output of the two-tube receiver and will furnish plenty of volume. However, as is the case with all audio-frequency transformers, the quality of reproduction is slightly affected because the amplification characteristic of the transformer favors some band of frequencies over others.

3. The resistance-coupled amplifier will not pro-

Facts! not Fancies!



Do you know where Condenser losses Come from?

RESISTANCE LOSSES are the losses which most seriously affect the efficiency of a condenser when at working radio frequencies. They arise from poor contacts between plates and from poor bearing contacts. Soldered plates and positive contact spring bearings reduce these losses to a minimum.

Eddy current losses occur in metal end plates and the condenser plates themselves. While not so serious as resistance losses, they increase with the frequency, and therefore should be kept as low as possible.

Dielectric losses are due to absorption of energy by the insulating material. Inasmuch as they vary inversely as the frequency, they have less effect upon the efficiency of a condenser at radio frequencies than any other set of losses. The use of metal end plates in short-wave reception to eliminate dielectric losses is never justified, because they introduce greater losses than well-designed end plates of good dielectric.

The design of General Radio Condensers is based on scientific facts and principles, not on style and fancies.

Specially shaped plates always in perfect alignment give the uniform wave-length variation which permits extremely sharp tuning.

Rotor plates are counterbalanced to make possible accurate dial settings.

In 1915 the General Radio Company introduced to this country the first Low Loss Condenser, and ever since has been the leader in condenser design.

Lower Losses and Lower Prices make General Radio Condensers the outstanding values of condenser design.

Licensed for multiple tuning under Hogan Patent No. 1,014,002

Type 247-H, with geared Vernier Capacity, 500 MMF. *Price*	$5.00
Type 247-F, without Vernier Capacity, 500 MMF. *Price*	$3.25

GENERAL RADIO CO.
CAMBRIDGE, MASS.

★

GENERAL RADIO
Quality Parts

★ Tested and approved by RADIO BROADCAST ★

duce as much volume as the push-pull amplifier but will be faultless in quality when properly adjusted. In all three types of amplifiers, the input connects to the two central blades of the double circuit jack.

The diagram, Fig. 4, is self-explanatory.

AUDIO TRANSFORMER MARKINGS

THE designations of binding post markings on audio-frequency transformers have become standardized to a great extent, but there are still some that do not follow general practice.

In Fig. 5, the binding post marks coincide with

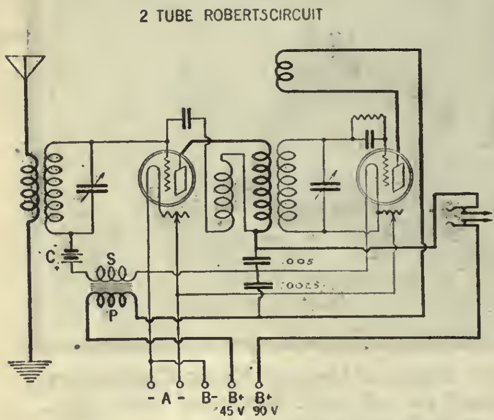


FIG. 4

the markings as applied to circuit diagrams. Fig. 6 shows how the marks appear when the primary posts are turned the other way around. The outside lead of the secondary is the point of high potential in the secondary circuit and usually connects to the grid. Standard practice has it that the outside of the primary should then go to the plate. However, be sure to have the grid connected to its proper post, then if results are not as expected it is well to try reversing the leads to the primary of the transformer. This is especially important in reflex circuits such as the Roberts.

NOTES ON THE ROBERTS CIRCUIT

THOSE who used Sickles coils in the Roberts circuit may have found that it was not possible to tune to the lower wavelengths. This is especially true of the first lot of Sickles coils manufactured. The condition may be remedied in two ways:

1. Change the connection of the return side of the secondary to the negative side of the A battery line instead of the positive, as is commonly shown in the circuit diagrams.

2. Remove five or six turns from the NP and tickler coils.

When removing turns from the tickler coil simply unwind them from the outside of the coil. When removing turns from the NP coils, unsolder the outside ends of both the green and white wires, and unwind both of them together until you have taken off six turns, then connect the green and white wire exactly as they were connected before.

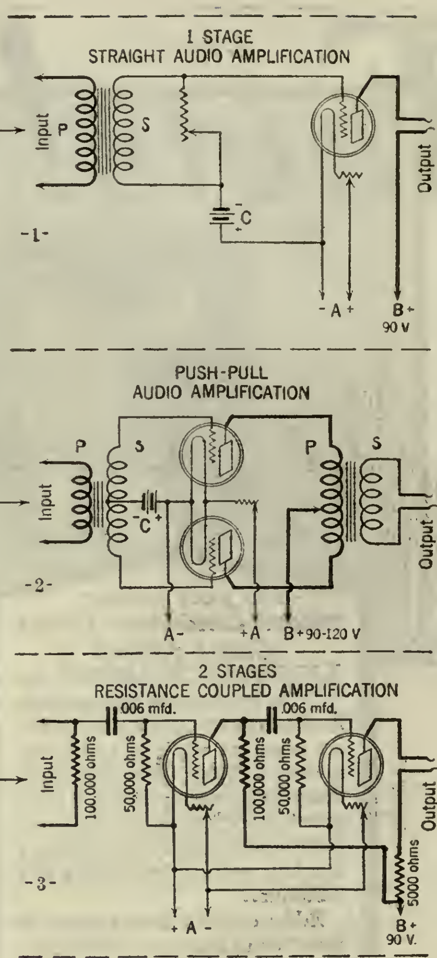


FIG. 5

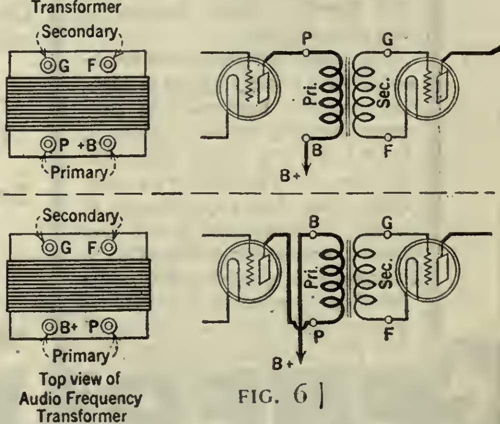


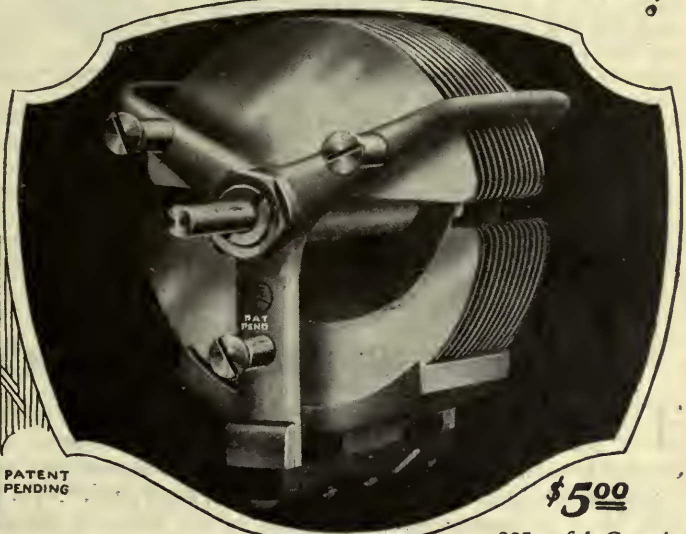
FIG. 6

This will make your set operate perfectly down to

Lacault Scores Again!

★

The new Ultra-Lowloss condenser is the latest radio improved device designed by R. E. Lacault, formerly Associate Editor of Radio News, the originator of Ultradyne Receivers and now Chief Engineer of Phenix Radio Corporation.



PATENT PENDING

$5.00

.005 m.f.d. Capacity

ULTRA-LOWLOSS
CONDENSER

LIKE every Lacault development, this new Ultra-Lowloss Condenser represents the pinnacle of ultra efficiency—overcomes losses usually experienced in other condensers.

Special design and cut of stator plates produces a straight line frequency curve, separates the stations of various wave lengths evenly over the dial range, making close tuning positive and easy.

With one station of known frequency located on the dial, other stations separated by the same number of kilocycles are the same number of degrees apart on the dial.

In the Lacault Ultra-Lowloss Condenser losses are reduced to a minimum by use of only one small strip of insulation, by the small amount of high resistance metal in the field and frame, and by a special monoblock mounting of fixed and movable plates.

At your dealer's, otherwise send purchase price and you will be supplied postpaid.

Design of lowloss coils furnished free with each condenser for amateur and broadcast frequencies showing which will function most efficiently with the condenser.

ULTRA-VERNIER
TUNING CONTROL

Simplifies radio tuning. Pencil-record a station on the dial—thereafter, simply turn the finder to your pencil mark to get that station instantly. Easy—quick to mount. Eliminates fumbling, guessing. Furnished clockwise or anti-clockwise in gold or silver finish. Gear ratio 20 to 1
Silver $2.50 Gold $3.50

R E L

This seal on a radio product is your assurance of satisfaction and guarantee of Lacault design.

To Manufacturers Who Wish to Improve Their Sets

The Ultra-Lowloss Condenser offers manufacturers the opportunity to greatly improve the present operation of their receiving sets.

Mr. Lacault will gladly consult with any manufacturer regarding the application of this condenser to his circuit for obtaining efficiency.

PHENIX RADIO CORPORATION, 116-C East 25th St., New York

★ Tested and approved by RADIO BROADCAST ★

one hundred and eighty meters and will not in any way weaken the received strength of the long wavelength stations. If for any reason you cannot get regeneration at five hundred and fifty meters increase the detector plate voltage.

When mounting the Sickles coils in the four-tube Roberts layout, the planes of the coils are practically opposite to that arrangement employing the Nazeley spiderwebs. The builder must exercise his own ingenuity in the proper placement of his coils so that they will not hinder the action of the variable condensers and he must make sure that the action of the tickler coil be not restricted.

The antenna coupler may be mounted directly on the panel slightly below the switch blade. This brings the tap leads quite close to the switch points. It also allows ready adjustment of the coupling between the primary and secondary.

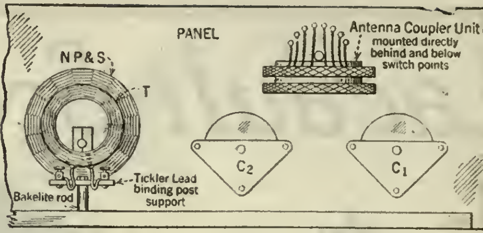


FIG. 7

The arrangement is as shown in Fig. 7 and permits of short leads to both switch points and variable condenser. A binding post strip may be mounted directly behind the tickler coil to accommodate the flexible leads from the tickler and the bus bar connections to it.

IMPORTANT ANNOUNCEMENT

THOUSANDS of you are writing the Grid for technical advice every month. The expense of framing a complete and exhaustive reply to each letter is very high. The editors have decided that the benefit of the questions and answers service will continue to be extended to regular subscribers, but that non-subscribers, from April 15 on, will be charged a fee of $1 for each letter of inquiry which they send to our technical department. Very frequently, our technical information service proves of definite money value to you who write us, for we are often able by a sentence or two of explanation, to put you on the right path before you have made a perhaps expensive mistake.

The occasional reader of RADIO BROADCAST will be charged a fee of $1 for complete reply to his questions, and the regular subscriber can continue to take advantage of the service as before. In that way, the non-subscriber will help share the cost of the technical staff whose service he gets. Every letter receives the benefit of the experience of the editor and the technical staff and every correspondent may be sure that his questions will receive careful consideration and reply.

When writing to the Grid, please use the blank printed below.

GRID INQUIRY BLANK

Editor, The Grid,
RADIO BROADCAST,
Garden City, New York.

Dear Sir,

Attached please find a sheet containing questions upon which kindly give me fullest possible information. I enclose stamped return envelope.

(Check the proper square)

☐ *I am a subscriber to* RADIO BROADCAST. *Information is to be supplied to me free of charge.*

☐ *I am not a subscriber. I enclose* $1 *to cover costs of a letter answering my questions.*

*My name is*______________________________

*My address is*______________________________

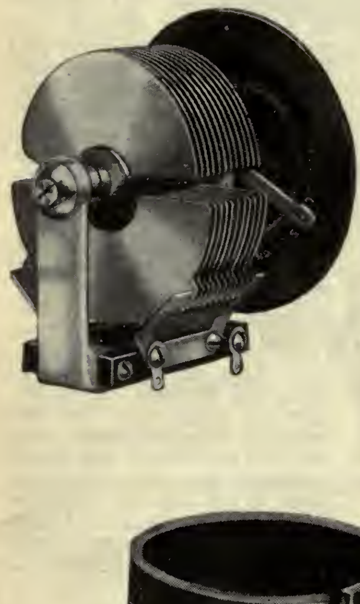
New Equipment

THE ANDREWS PADDLEWHEEL COIL

A well made inductance designed to give a higher ratio of inductance to resistance. The several groups of spiral windings are space insulated from each other without the use of any adhesives or dope. Tuned with a .00025 mfd. condenser, this R. F. transformer inductance has a range from 200 to 600 meters. Made by Radio Units Inc., Maywood, Illinois. Price $3.00

TOGGLE BATTERY SWITCH

A new battery switch designed for use in the radio receiver. It is neat in appearance with a polished nickel finish and has large make-and-break contact surfaces. The wide spacing of the terminals permits ease in making connections. It is easily mounted on the panel with only one hole required. Made by The Cutler-Hammer Mfg. Co., Milwaukee, Wisconsin



KELLOGG CONDENSER

A low loss variable condenser with a heavy brass frame containing a minimum amount of metal. Direct three-point contact with the rotor assures positive connection. A special Kellogg dial in conjunction with the vernier attachment makes for very fine tuning adjustment. Made by the Kellogg Switchboard and Supply Co., Adams and Aberdeen Sts., Chicago, Illinois

"BALLGRIP" SOCKET

A molded bakelite socket of unusual design. Contact with the tube prongs is obtained through a ball socket arrangement molded into the base of the unit. The construction is such as to eliminate the possibility of internal short circuiting. Made by Quality Molded Products, Inc., 1 Exchange Place, Jersey City, New Jersey. Price $1.25

AMPLION LOUD SPEAKER

This speaker is designed to give great sensitivity and naturalness of tone. The Amplion "Floating Diaphragm," kept from contact with metal by rubber gaskets, rests on a narrow ledge in the case, lightly held there by a spring ring with enough pressure to prevent "chatter" when extreme volume is desired. Another feature of the Amplion is the use of rubber insulation between the several sections of the horn to eliminate any ring or resonance. Made by The Amplion Corporation of America, 280 Madison Ave., New York City

RADIO BROADCAST

Vol. 7, No. 2 June, 1925

The Story of Broadcasting in England

The Growth of the Radio Giant in Great Britain Compared With that in America—How John Bull Regulates Broadcasting—The New Radio Import and Licensing Regulations

By F. J. BROWN

Late Assistant Secretary of the British Post Office

BROADCASTING in Great Britain began in a very small way by a half-hour's transmission of a musical program once a week from a station belonging to the Marconi Company at Writtle, in Essex. This was authorized as a concession to the two or three thousand amateurs who at that time had received experimental licenses from the Post Office, and who wished to test the efficiency of their apparatus by picking up Writtle's signals. They were mainly gramophone records, but occasionally more ambitious programs were introduced.

This was the limit of development in the winter of 1921-2, when I visited Washington as Expert Adviser on Communications to the British Delegation at the Arms Conference. At that time, the broadcasting boom in America had just begun. Fortunately, I was in a position to receive full information as to its progress from my friends General Squier, Doctor Austin and Doctor Cohen; and through their courtesy I was present at some of the meetings of Mr. Hoover's first Radio Conference, where I met other world-famous American radio authorities. An extract from a letter which I wrote to one of my colleagues in London on the subject in February, 1922, may be of some historical interest:

> The thing which has made the most remarkable progress here recently is broadcasting. The number of receiving sets which are being used is marvelous. The Westinghouse people gave it a great impetus. They have put up several broadcasting stations, and are stated to be selling receiving sets (varying in price from $30 to $150) at the rate of 25,000 a month, and are then quite unable to meet the demand. Other people are following suit, and it is likely that there are now between 200,000 and 300,000 receiving sets in use, though the number can't be stated exactly, as licenses are not issued for reception. The sending stations broadcast on 360 meters. They probably interfere to some extent with ship-and-shore work, and they certainly tend to interfere with one another. I heard a program from one of them last Sunday afternoon at Dr. Frank B. Jewett's home, by means of his boy's receiving set. Both speech and music were quite clear. The opinion is growing here that broadcasting is the main sphere of wireless in the future.

On my return to London in March, 1922, I

found that applications were being made to the Post Office by certain wireless manufacturing firms for permission to broadcast programs of music, etc., for the purpose of promoting the sale of their apparatus.

ENGLAND REFUSED TO GRANT A BROADCASTING MONOPOLY

IT SOON became evident that, within the circumscribed area of Great Britain, it would be impossible to permit the establishment of broadcasting stations with anything like the freedom which was being granted in America. It was equally contrary to the policy of the British Government to grant a monopoly of broadcasting to one, or even to two or three, manufacturing firms, as this would place them in a superior position to their competitors for pushing the sale of their goods.

In these circumstances, the whole question was referred to the Imperial Communications Committee. This committee is composed of representatives of the Army, Navy, Air Force, Post Office, and other British government departments which are interested in wireless. It is presided over by a member of the Cabinet, and considers all important questions of imperial policy with regard to wireless and cables. To this committee I explained the position which had arisen in America, and the difficulties which were presenting themselves in England.

The Committee recommended that an endeavor should be made to induce the various manufacturing firms to coöperate in the establishment of a single Broadcasting Company, which, it was thought, might be allowed to establish stations of moderate power (say from 1½ to 3 kilowatts) in eight areas, centering on London, Birmingham, Cardiff, Plymouth, Manchester, Newcastle, Edinburgh (or Glasgow) and Aberdeen. These stations would roughly cover the whole of the country.

The Committee further recommended that a band of wavelengths from 350 to 425 meters should be assigned to the stations. They considered that the Broadcasting Company should not be allowed to broadcast advertising matter, or to receive payment for matter broadcast. They also considered that, as the new organization would be placed in a privileged position (in that no competitor would be allowed) it was only fair to the press and the news agencies that its operations as a distributor of news should be rather severely restricted. They proposed that its revenue should be provided mainly by a share of one-half of the license-fee of ten shillings (about $2.50) collected by the Post Office on the issue of each receiving license.

In this connection, it should be mentioned that, in Great Britain (unlike the United States), a license from a governmental authority has always been held to be necessary for each receiving set, as well as for transmitting apparatus.

Facts From Headquarters

COMPARISONS, if not exactly odious, are frequently too easily and carelessly made. One hears it said that in England the radio people do it this way, or that, which is better or worse than our method, as the case may be. This story of affairs radio in England is authoritative and extremely interesting to any one who has wondered how England has handled her radio problems. Mr. Brown, the author, was, until last January, the Assistant Secretary of the British Post Office and in administrative control of broadcasting and other wireless activities for the Government. He tells in interesting fashion just what happened in England to the licensing system which was inaugurated when broadcasting got its real start there in November, 1922—exactly one year after regular broadcasting service began in this country. It was the home constructor who spoiled the scheme and the revised schedule under which receiving licenses are now granted takes him into consideration. This article by Mr. Brown and "How the Government Is Regulating Radio Broadcasting" by R. S. McBride in RADIO BROADCAST for May, are of especial interest because they show how the two governments are trying to solve their administrative problems.—THE EDITOR

ENGLISH BROADCASTING BEGAN IN NOVEMBER, 1922

MR. KELLAWAY, who was Postmaster General at the time (he has since become Managing Director of the Marconi Company), threw himself into the scheme with much avidity; and on May 4th, 1922, he announced in the House of Commons that he had decided to allow the establishment of a limited number of broadcasting stations, and was calling a conference of the firms who had applied for licenses to open them. This conference was held a fortnight later and was at-

tended by representatives of twenty-four firms. A committee of manufacturers was subsequently appointed by these firms, in conjunction with all other firms who were known to be engaged in the manufacture of wireless apparatus. Prolonged negotiations took place.

At one stage, the negotiations almost broke down. It seemed to be impossible for the manufacturers to agree on the formation of a single broadcasting organization: there was a marked tendency toward a division into two groups, which would have involved the creation of two broadcasting companies, each representing one of the groups. But finally all difficulties were surmounted and a single broadcasting organization was formed—although it was not until January 18th, 1923, that a license was actually issued to that organization. In the meantime (on November 15th), a daily broadcasting service had been started at the London station, and later at Birmingham and Manchester. The issue of broadcast receiving licenses by the Post Office began November 1, 1922.

HOW ENGLAND PLANNED BROADCASTING

THE scheme as embodied in the license to the broadcasting organization was recognized from the start as being necessarily of a provisional nature; and the term of the license was accordingly limited to two years. The principal features of the scheme have been officially summarized as follows:—

(a) A Company (called the British Broadcasting Company) to be formed among British manufacturers of wireless apparatus. Any such manufacturer to be entitled to join the Company upon his subscribing for one or more £1 shares, and entering into an agreement in the form approved by the Postmaster General.

(b The Company to establish eight broadcasting stations and to provide a regular service to the reasonable satisfaction of the Postmaster General. The Company to pay a royalty of £50 per annum in respect of each station.

(c) The Post Office to issue broadcast receiving licenses at a fee of 10*s*. a year, containing a condition that the sets used, and certain parts (viz., valves, valve amplifiers, head telephones, and loud speakers), must bear a standard mark—"B. B. C.—Type approved by Postmaster General."

(d) The Post Office to pay the Company a sum equal to one half of the license fees received in respect of broadcast and experimental receiving licenses.

RADIO LISTENERS IN GERMANY

Broadcasting in the German Republic has not attained as great popularity as in either England or the United States. England is very completely served by a system of master stations and small local relay stations. The master stations in the larger centers originate programs of their own and relay programs from the London studio of the Broadcasting Company. This system, perfectly suited to England, could hardly be applied to American conditions. American stations have been "tied" together for programs from WEAF, New York, but the "tie-up" has been usually with stations only as far west as the Mississippi because of the difference in time between New York and the Central and Far West. The German enthusiasts here are using a receiver which is incorporated in a table lamp. The loop is covered

(e) The sets sold by members of the Company, as a condition of bearing the "B. B. C." mark, to be British made, to carry a payment to the Company in accordance with a tariff approved by the Postmaster General, and to require the Postmaster General's approval of the type of set, such approval being confined to securing that the apparatus would not be likely to cause radiation from the receiving antenna.

(f) No advertising or paid matter to be broadcast, and only such news as is obtained from news agencies approved by the Postmaster General.

(g) The Company not to pay dividends at a higher rate than $7\frac{1}{2}$ per cent. per annum.

(h) An understanding to be given that the requisite capital would be subscribed, that the service would be continued throughout the period of the license, and that any deficit should be met. Six firms undertook these responsibilities and were given the right each to nominate a director, two additional directors being nominated by the remaining firms who might take up shares, and an independent chairman being appointed by the six firms.

THE RADIO CHILD GROWS

THE scheme excited much public interest and was, on the whole, well received. In the winter months following the first issue of broadcast receiving licenses by the Post Office (on November 1, 1922), a considerable number of these licenses were sold. By the end of March, 1923, the total was about 150,000 and the income of the Company from all licenses was about £60,000 (about $1,270,000). However, at that time difficulties began to be encountered. As already explained, the broadcast receiving license was applicable only to sets bearing the "B. B. C." mark. But in explaining the scheme to the House of Commons in July, 1922, Mr. Kellaway had given an assurance that "provision would be made under which amateurs who constructed their own receiving sets would be allowed to use them." The view then taken by the Post Office was that, if a person were sufficiently skilled to make his own apparatus, he would have sufficient knowledge of the subject to be described as an experimenter, and to be entitled to hold the experimental license which the Post Office, in its arrangements with the Company, had reserved the right to issue independently of the broadcast receiving license. I will say that the Post Office at that time had no adequate conception of the extent to which members of the public would make their own apparatus. Moreover, on the strength of Mr. Kellaway's assurance, firms began to place on the market ready-made parts which any intelligent person could build up into an effective receiving set by the aid of a diagram and a screw-driver. Such persons could obviously not properly be regarded as experimenters, and it would not have been fair to the Broadcasting Company, and especially to the manufacturing firms who constituted that Company, to issue experimental licenses to such persons, seeing that their apparatus carried no royalty payment to the Broadcasting Company and provided no revenue to the manufacturer.

THEN CAME THE HOME CONSTRUCTOR

THE Post Office had, indeed, no license to fit the case of these persons. The experimental license was not applicable, and they were not entitled to the broadcast receiving license, inasmuch as it covered apparatus bearing the B. B. C. mark only. A deadlock had, in fact, arisen. Many thousands of "home constructors" were applying for licenses and their demand could not be met. What was to be done? Suggestions were made from various sources that a new type of "constructor's license" should be issued; but, although the Broadcasting Company agreed in principle to the issue of such a license, notwithstanding the fact that they need not have done so under the terms of their operating license, it proved impossible for the Post Office and the Company to arrive at an agreement as to the precise conditions upon which such licenses should be issued. A situation intolerable alike to the Post Office, to the Company and to the general community having thus arisen, Sir William Joynson-Hicks, who was then Postmaster General, referred the question to a committee known as the Broadcasting Committee. The Committee comprised representatives of the Post Office, of the Broadcasting Company, of the House of Commons, of the radio amateurs and of the general public. It held several meetings, and gave the most careful attention to the whole subject. Finally it recommended several important modifications of the original scheme—although it recognized that, as the original proposal had been embodied in a legal agreement between the Post Office and the Broadcasting Company, these modifications could not be carried out without the consent of the Company until that agreement had expired at the end of 1924. The substance of these modifications was as follows:

(1) A uniform and simple type of receiving license at 10*s.* ($2.50) to be issued and placed on sale at Post Offices without any formalities—the restriction against the use of apparatus not bearing the "B. B. C." mark being abolished.

(2) The Broadcasting Company to receive a maximum of 7*s*.6*d*. instead of 5*s*.—out of the license fee, subject to the operation of a sliding scale under which the payment per license would decrease as the number of licenses increased.
(3) The method of deriving revenue on royalties on the sale of "B. B. C." apparatus to be discontinued.
(4) Effective measures to be taken to prevent evasion of the license, and certain additional statutory powers to be obtained to strengthen the Postmaster General's hands.
(5) The gradual extension of the broadcasting of news to be allowed under proper safeguards.
(6) The broadcast band of wavelengths (hitherto from 350 to 425 meters) to be increased so as to include wavelengths between 300 and 500 meters (except those from 440 to 460 meters which are used for maritime purposes.
(7) The Broadcasting Company's license to be extended from the end of 1924 to the end of 1926, but the Government to keep its hands free to grant additional licenses if considered desirable.

The Committee paid a well deserved tribute to the excellent service provided by the Broadcasting Company—a tribute which, when the Report was published, was generally echoed by the press.

SOLVING A DIFFICULT PROBLEM

WHEN the then Postmaster General, Sir Laming Worthington-Evans, received the Report in August, 1923, he immediately initiated further negotiations with the Broadcasting Company. He found the Company, as might have been expected, unwilling to accept the Report as it stood, in view of their strong legal position. They met him, however, in a very reasonable spirit and a compromise was arranged without serious difficulty. This compromise had been tentatively suggested while the Committee was sitting, and both parties, as well as the public, were well satisfied with it. Under this compromise, which was announced about the beginning of October, 1923, it was agreed that up to the end of that month a special form of license, known as the "interim license," should be issued in order to "whitewash" the many unlicensed receiving sets which, it was believed, had come into existence during the period of the deadlock. The fee for this "interim license" was to be 15*s*. a year, out of which the Broadcasting Company was to receive 12*s*.6*d*. In addition to this form of license, the broadcast receiving license at 10*s*., applicable only to apparatus bearing the B. B. C. mark, was continue to be issued; and a constructor's license at 15*s*. was to be introduced, applicable to apparatus made or put together by or on behalf of the licensee himself. The only special condition of this license was to be an undertaking by the licensee not intentionally to use, in the construction of his set, material or parts made elsewhere than in Great Britain.

ONE MILLION TWO HUNDRED THOUSAND RECEIVER LICENSES IN ENGLAND

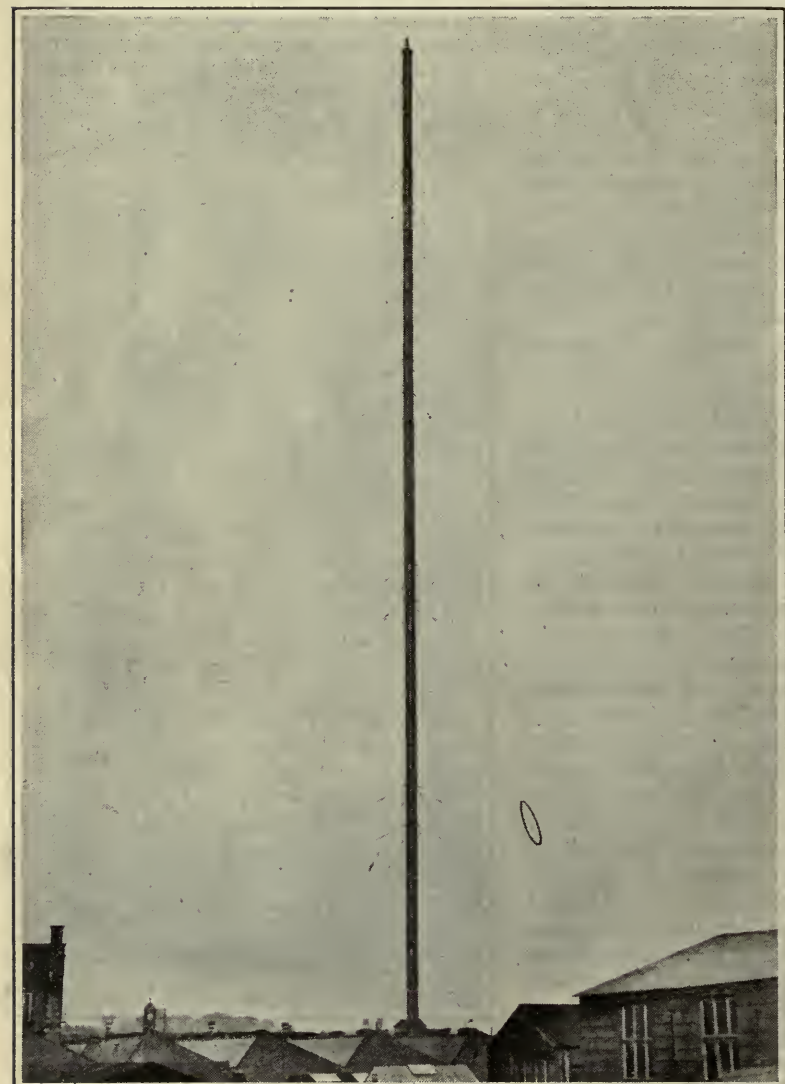
THERE was immediately a very large demand for the "interim license," and some 200,000 of these were issued up to the end of October. The constructor's license also proved popular, being issued in the proportion of about two to one B. B. C. license. The total number of licenses continued to grow at a rapid rate, and by the end of the year it had reached about 500,000. Each month of the new year also saw a rapid growth,

THE MASTS OF THE NEW BRITISH STATION
Which will soon be opened at Daventry. This station will use 1600 meters and about 25 kilowatts and will originate programs of its own as well as broadcasting programs from the main London studio of the British Broadcasting Company. The site of the station is 600 feet above sea level and the ground itself is about 300 feet above the surrounding territory. The two masts are 500 feet high and 800 feet apart

although there was some falling off during the summer months. By October, 1924, the total had practically reached 1,000,000 and at the time of writing (February, 1925,) it is 1,200,000.

In the new arrangements with the Broadcasting Company, the Postmaster General had reserved the right to issue on January 1st, 1925, the simple and uniform license (at 10*s*.) which had been recommended by the Broadcasting Committee. In view of the fact that this further reform was drawing near, and that there would be difficulty in inducing the public to pay 15*s*. for the constructor's license in the autumn of 1924 instead of waiting until the beginning of 1925 to secure a license for 10*s*., the Broadcasting Company agreed to introduce this further reform at an earlier date. The growth in the number of licenses, and consequently in their revenue, had put them in a good financial position; and they accordingly agreed that the 10*s*. license should be issued as from July 1st, 1924. The condition about British manufacture was to be retained until the end of the year. This reduction in the license fee no doubt assisted in the growth in the number of licenses above referred to. On and from January 1st, 1925, a simple form of license (at 10*s*.), without any restriction as to the country of origin of the licensed apparatus, has been in existence.

Meanwhile, with the increase in revenue, the Broadcasting Company had been able to maintain a very efficient service at their original stations, and they also had been able to erect a number of additional stations. These, for the most part, have been so-called relay stations, with a power of from 100 to 200 watts. A more interesting development, however, has been the use, experimentally, of



THE CHELMSFORD MAST

Of the experimental station 5XX of the British Broadcasting Company. The usual broadcast wavelengths of the various English stations are much the same as in this country, but 5XX uses a 1600 meter wavelength and a power of about 25 kilowatts. The Broadcasting Company engineers were testing with this station the possibilities of using a high powered station, located at a central point, broadcasting programs to be picked up anywhere in England with a crystal receiver

a much higher-powered station. For this experimental work a 20-kilowatt station of the Marconi Company at Chelmsford has been used, and the effect of its use upon other services has been closely watched by the government experts, in order to see whether undue interference was likely to be caused. On the whole the results were satisfactory; and the Company was accordingly given permission to erect a permanent station at Daventry (near the center of England). This station is now nearing completion. It will use a wavelength of 1600 meters and will broadcast an independent program, which will be transmitted from London by means of the ordinary telephone circuits and then relayed. This station will, it is expected, enable programs to be received by a simple crystal set within a radius of about 100 miles, as compared with the crystal radius of about ten or fifteen miles which is covered by the existing main stations of the Company, and the crystal radius of four or five miles which is covered by the relay stations. It is possible that the Company may wish to erect similar high-powered stations in other parts of the country, with the object of bringing practically the whole population within crystal radius.

THE BRITISH LICENSING SCHEME IS WORKING

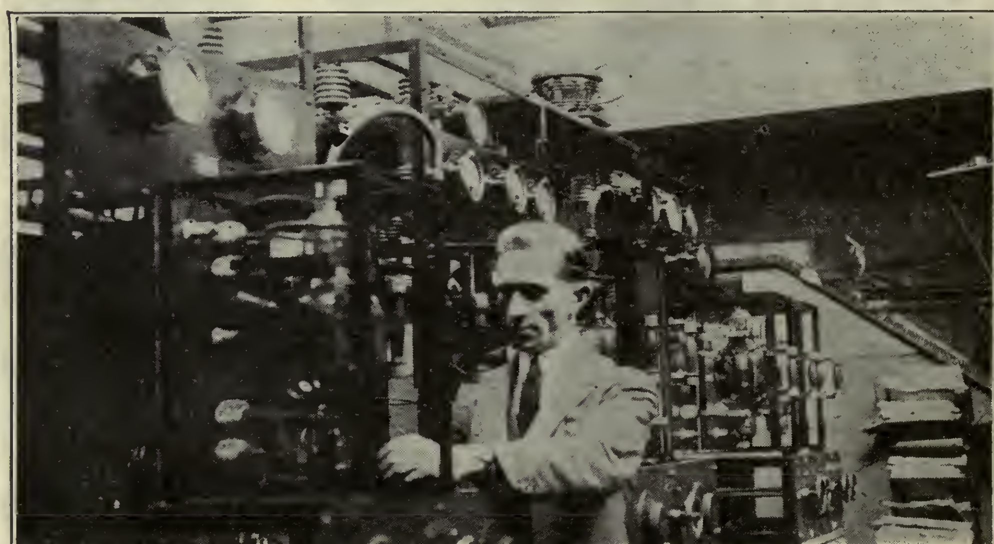
SINCE the revised scheme of licensing was brought into operation in October, 1923, the arrangements have worked with remarkable smoothness and success. Those who have been concerned with them flatter themselves that the arrangements have resulted in what is probably, on the whole, the most satisfactory and efficient broadcasting service in the world. It is, of course, extremely doubtful whether the same arrangements could have been adopted in the United States, where no attempt has ever been made to introduce a licensing system for receiving sets. Where the public have once got into the habit of installing receiving sets without let or hindrance it would be a very difficult matter to induce them to accept licenses and to pay a licensing fee. Hence, I do not for a moment suggest that the system which has been applied in Great Britain would be suitable for the United States. But here, where

APPARATUS AT THE GLASGOW STATION

Of the British Broadcasting Company. Many of the switches in the foreground are for controlling the wire lines between the various stations

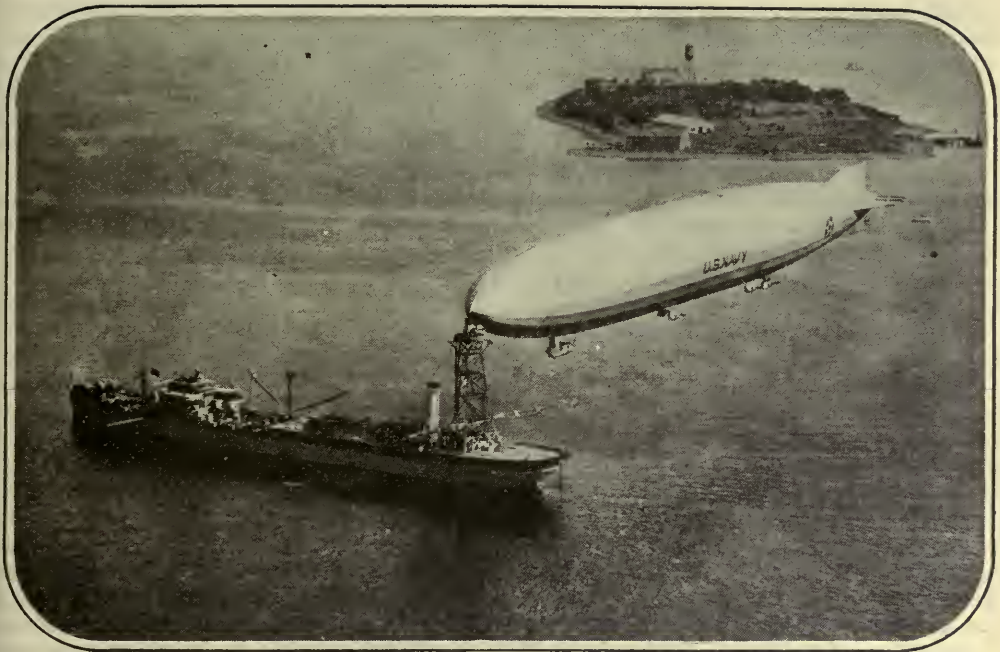
the licensing habit is already in existence, it has proved a very simple and efficient method of collecting funds for the purpose of the broadcasting service—a matter which, I understand, is likely eventually to result in a rather difficult problem in America. No doubt there is some amount of evasion in Great Britain; how much evasion, there is no means of saying: but that the evasion runs to the lengths which some suggest is quite improbable. The figures, in fact, speak for themselves. There are 1,200,000 licenses in existence at the present moment. The same ratio of licenses to population would give a total of nearly 4,000,000 licenses if the population of Great Britain were as large as that of the United States. Of course, no one knows how many households have receiving sets in the United States; but I think the most authoritative estimates place the number at between 5,000,000 and 6,000,000. Bearing in mind the greater prevalence of the telephone habit in the United States than in Great Britain, one may reasonably assume that the habit of broadcast reception is also more widely spread in the States than here. And taking these factors into account, one may safely conclude that the great majority of listeners in Great Britain and Ireland have taken out licenses.

But of late a source of difficulty has arisen. Hypercritical persons have been examining the Wireless Telegraphy Act of 1904, upon which the whole system of licensing is based, and have raised the question whether it really applies to receiving sets at all, as distinct from sending sets. I am not a lawyer, but I know the opinion of lawyers who are well qualified to judge; and, personally, I have no doubt in the matter at all. The question, however, has never been referred to a Court of Law, so that there is no authoritative decision on the subject; and the Postmaster General, rather than risk an adverse decision, has decided that no proceedings shall be taken against any person who fails to take out a license for a receiving set, until the point has been placed beyond the shadow of doubt by means of new legislation which he has recently introduced in the House of Commons. This decision has no doubt resulted in some decrease in the number of licenses taken out; but one is inclined to believe that the great majority of the public are disposed to play fair in this matter and, irrespective of the Postmaster General's decision, to contribute their quota to the expenses of the broadcast programs to which they listen. The new Bill, besides setting this point at rest, imposes a number of new provisions in regard to licensing which do not in particular apply to broadcasting: and, as I write, it is arousing a good deal of criticism in Parliament and the press. What will be its fate does not yet appear; but the system of licensing in connection with the broadcasting arrangements has proved so convenient and popular that one cannot imagine that Parliament will scrap it.



ENGLISH BROADCASTING APPARATUS

Is not very different from that used by most American stations. One of the British stations, indeed, uses apparatus manufactured by an American company



THE U. S. S. "SHENANDOAH"

During the recent transcontinental trip of the *Shenandoah*, the Naval radio operators aboard the ship were in constant communication through their short wave transmission with radio amateurs in all parts of the country, as well as with the Naval Laboratory at Belleview, near Washington. A wavelength of 80 meters was used. The coöperation extended by the amateurs in this instance was one of many examples of a similar sort

New Paths for the Short Waves

Details of the Great Contributions Made by the American Radio Amateur to Radio Transmitting Knowledge—How the Amateurs Are Coöperating With the Navy—A New Theory for Radio Transmission

By KENNETH BOLLES

THE first congress of the International Amateur Radio Union which was held in Paris, April 14 to 19, with many delegates present speaking a great variety of languages, is really the first practical indication that amateur radio is destined to become an efficient and orderly world force. It has taken hardly two years for amateur radio to grow from a localized activity, chiefly confined to the United States, to an international relay system with far reaching influence. It must have its regulations and understandings in order that equal freedom and fair play may be given to those who desire to participate in its activities. The congress is the first official step in making such provisions.

Amateur radio, under the guidance of the American Radio Relay League, has trained some 20,000 young men in the principles of radio science and in a knowledge of the code. Those who refer to it as purely a sport reckon without a true appreciation of its influence in the development of commercial radio and broadcasting. Hiram Percy Maxim, and Kenneth B. Warner, president, and secretary of the A. R. R. L., respectively, and delegates to the I. A. R. U., said upon leaving, that they believed international friendships by radio would be a factor in bringing world peace.

They said that in all countries, where amateurs are found, hope may be held for swift progress in all lines of radio science.

The progress of amateur radio is already being realized by governments of various countries where amateurs are active. The I. A. R. U. may crystalize the opinion of amateurs all over the world for the benefit of those countries which desire technical guidance in drawing up regulations governing private international communication. The desire of amateurs to gain the utmost freedom is no stronger than their wish to turn over to the radio public the results of their deductions and experiments.

What have the amateurs done to warrant any sort of world-wide recognition? What practical thing have they accomplished that would justify giving them greater freedom? Almost everyone is familiar with their message handling during emergencies, their coöperation with the American Railway Association, their assistance to the Navy Department during the transcontinental trip of the *Shenandoah*, but these are outside of their established routine and are not as convincing as those things which are a lasting and permanent benefit to radio development.

A Record of Accomplishment

The American Radio Relay League is one of the unique organizations in America—a land of many organizations. It was founded a little over ten years ago to band together amateur radio telegraph experimenters whose activities were largely concerned with exchanging private messages with one another over comparatively short distances. Now, more than 15,000 experimenters are members and the exchange of messages is but a small part of their activities. Perhaps the field in which they have aroused most interest is in their experiments with very short radio waves. Every reader of newspapers knows that the only link that Donald MacMillan had with the outside world when he made the recent trip of exploration in the Arctic was that forged by amateur radio communication. The Department of Commerce recently recognized the excellent development work the radio amateurs were doing with short waves by granting them a band of waves between .7496 and .7477 meter. The present article describes some of the activities of the American Radio Relay League and tells particularly of the work of two of their most prominent members, John L. Reinartz, and F. H. Schnell. The work of these earnest amateurs is reflected in their excellent and authoritative publication, *Q S T*, and the Navy Department has shown its confidence in their earnestness by arranging to have Mr. Schnell, Traffic Manager of the League, accompany the Pacific fleet on its manoeuvres this summer.—THE EDITOR

WHAT HAVE THE AMATEURS DONE?

The one great outstanding contribution of amateurs to the radio art is their development of the short waves. They have gone farther in this field than any other group. They have proved short waves are of unsuspected importance. The various radio groups have become interested in these bands because of the pioneer work that has been done by amateurs.

With these short bands given over to their exclusive use, amateurs in this country have demonstrated they can send their signals to any part of the world where there are radio fans and radio receivers to pick them up. It has become practically impossible to name any country in the world where local amateurs are at all active that has not heard American amateurs calling.

The signals of operators on the west coast of this country are being heard regularly in South America and over similar distances, almost with as much ease as European and American amateurs could communicate with one another a year ago. English and New Zealand "brasspounders" demonstrate their superior skill by communicating with the Antipodes. Bartholomew Molinari of San Francisco, winner of the Hoover amateur efficiency cup for 1924, reports that his signals have been heard in the following lands and islands: France, England, Italy, Chile, Argentina, Cuba, Panama, Tahiti, Tonga, Samoa, Pribiloff Islands, Tasmania, Korea, China, British India, South Africa, Philippine Islands, Malay Straits Settlements, on ships off Cape Horn and off the coasts of Borneo, Guatemala, Honduras, Nicaragua and Costa Rica, and the Republic of Salvador.

The assumption upon reading this and many other similar records, is that short waves and low power are as capable of covering as great distances as long waves and high power at a cost that is astonishingly less.

That the development of short waves has

by no means been exhausted was demonstrated recently by two important events, one of these being the decision of the Navy Department to seek the coöperation of American Radio Relay League amateurs in an investigation of short waves during manœuvers of the Pacific Fleet this summer; the other, the announcement of John L. Reinartz's theory of daylight transmission.

WHAT THE AMATEURS ARE DOING

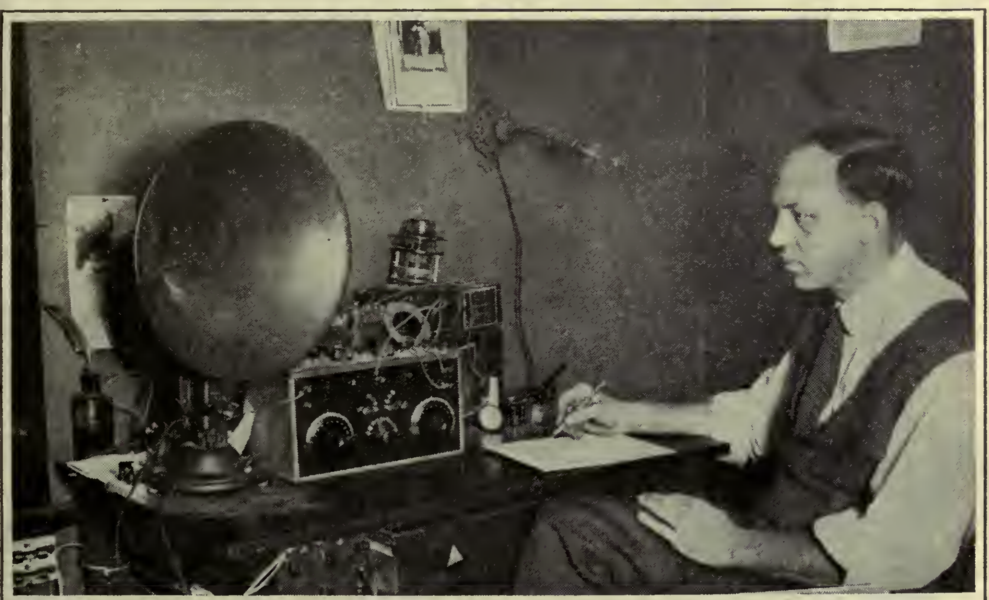
IN ORDER to carry out the navy experiments successfully, F. H. Schnell, traffic manager of the American Radio Relay League who has been given a seven months' leave of absence by the League, will conduct tests with amateurs in many countries. His work will serve as one more important link between American amateurs and transmitting operators in other parts of the world, and he will, at the same time, demonstrate under official supervision what short waves can do. His experience as traffic manager of the A. R. R. L. has given him a wide acquaintance among amateurs which the Navy believed would be of great service in the short wave tests and so it called him in active service in the Department with the rank of lieutenant.

It is significant that following closely upon the first international amateur congress, the U. S. S. *Seattle* is now steaming in Pacific waters equipped, among other apparatus, with a typical amateur radio transmitter and receiver. This first amateur type station to be installed on a Navy ship will have the call NRRL. One may imagine the interest and enthusiasm in which amateurs in Australasia, the Philippine Islands, China, Japan, South America, and probably Europe and Africa will listen for this special Navy station, pleased with the thought that the communication they have helped to build has been recognized by the United States Navy.

THE U. S. S. "SEATTLE" EXPERIMENTS

THE amateurs who intend to listen for NRRL, no matter whether they are located in this or foreign countries, must be prepared to tune-in on a number of different wavelengths, for the tests are to cover several bands of short waves. At night, the main set at NRRL will transmit on 54.4 meters while in daylight it will shift to 27.2 meters. There will also be transmitters functioning on 20, 40, and 80 meters.

If it is found that the low power amateur stations employing less than one kilowatt are just as efficient as regards the distance covered and dependability of operation, it may be seen very readily that their use would mean



JOHN L. REINARTZ

Of South Manchester, Connecticut. Mr. Reinartz, using a wavelength of 21 meters and low power recently established communication with an amateur on the Pacific coast at noon. This remarkable feat showed strikingly the possibilities of short wave radio work

LIEUTENANT F. H. SCHNELL

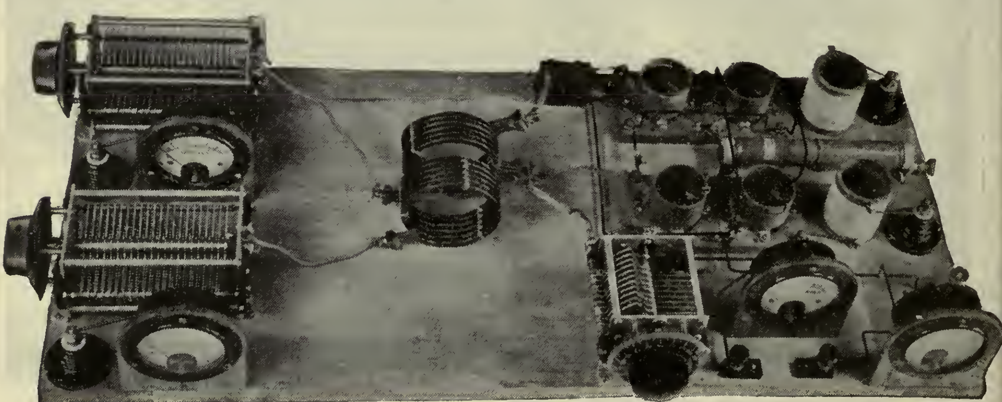
Traffic manager of the American Radio Relay League. Mr. Schnell has been commissioned a Lieutenant in the Navy, assigned to the fleet on its Pacific cruise this summer. He will experiment with short radio waves and communicate with transmitting amateurs all over the world. The American Radio Relay League has about 20,000 members, excellently organized for intercommunication by radio. Members of the organization have communicated great distances using short wavelengths and very low power

a tremendous saving in the cost of the initial radio installation. The average amateur transmitter can be put together for about $250. while the high power navy set may average somewhere around $6000. It is even possible that if the tests made by NRRL are quite successful, we may see the Navy changing to low wave sets in preference to the longer wave, high power transmitters they are now using.

The reader should not interpret from this that the Navy is just now beginning to show an interest in the short waves, for it has been working hand in hand with amateurs for some time. Some of the most important experiments ever made in connection with low power transmission have been undertaken through correct coöperation between the Navy and amateur operators. The Navy has been using short wave transmitters on certain ships for many months and as long as two years ago, the short wave station of the U. S. S. *Ohio* was heard on the west coast.

The theory of daylight transmission previously mentioned in this article was a direct result of tests conducted by John L. Reinartz at South Manchester, Connecticut, and Dr. A. H. Taylor of the Naval Research Laboratory at Bellevue, Washington, D. C. The experiments which they started a year ago are still in progress. As a result Reinartz has demonstrated repeatedly that with a low powered transmitter using 21 meters, great distances can be covered in daylight. While transmitting from his station at South Manchester, Connecticut, about noon, Eastern Standard Time, his signals have been heard by amateurs on the west coast, in Florida, and in England, and he has several times conducted two-way communication direct with the Pacific coast at noon.

This gave definite proof that the very short waves travel farther in the daytime than they do at night, which is the reverse of what has already been known, that the long



THE 200 WATT TUBE TRANSMITTER

For use on very short waves which Mr. Schnell will use for experimental communication while he accompanies the Navy fleet on its Pacific cruise this summer

THE U. S. S. "SEATTLE"

Where Mr. Schnell will make his headquarters during his short wave tests. The Navy has shown great interest in the possibilities of short wave communication and is coöperating with the American radio amateurs who have contributed a great deal to the development of this transmission. At present, Naval communication is carried on chiefly by long wave high power radio transmitters, which are not only expensive, but subject to the familiar effects of daylight fading

waves could cover great distances at night, but were unable to travel very far under daylight conditions. Until then, it was thought the ionization of the atmosphere caused by the sun's rays had practically the same unfortunate effect on all waves and that daylight might be always a big hindrance to radio transmission.

THE EFFICIENCY OF SHORT WAVES

IN ADDITION to making the bare discovery, Mr. Reinartz developed a theory which appears to explain the phenomenon satisfactorily. It is based on the well known fact that radio waves are reflected by the atmosphere in the same manner that light rays are reflected with the aid of a polished surface. The distance that radio waves will travel in daylight is determined by the length of the wave, for it appears it is this factor which controls the height at which the reflection takes place.

There is a definite relationship which connects the position and effect of the sun with the length of the radio wave and the distance that it will be reflected. The depth of the reflecting layer varies with the time of day and season. The shorter waves seemingly have the peculiar faculty of penetrating farther into the ionization layer and they are therefore capable of being reflected to a much greater distance.

"The fact that the shorter wave penetrates the ionization layer to a greater height," declares Mr. Reinartz, "causes the reflection to take place at a higher altitude than would be the case for the longer; therefore, the diameter of the circle at which the short wave again appears on the earth's surface is larger. Inside of this circle there is no evidence of the radio wave until one gets very close to the transmitting station. The reason for this is that the waves which travel along the earth's surface have been subjected to all the absorbing influence which that surface carries, while those which went up to the ionized layer and were reflected back have traveled through a considerable space and very little energy has been lost. This makes it possible to cover tremendous distances with but a fraction of the energy needed for some of the longer waves.

"It is possible to use this information in such a way as to obtain reliable daylight ranges considerably in excess of reliable night ranges obtainable with the same power."

Mr. Reinartz makes the prediction that this year will see communication established between amateurs of the United States and Australasia on a wavelength of about 20 meters in broad daylight. Mr. Reinartz will have an intensely interesting opportunity to test his

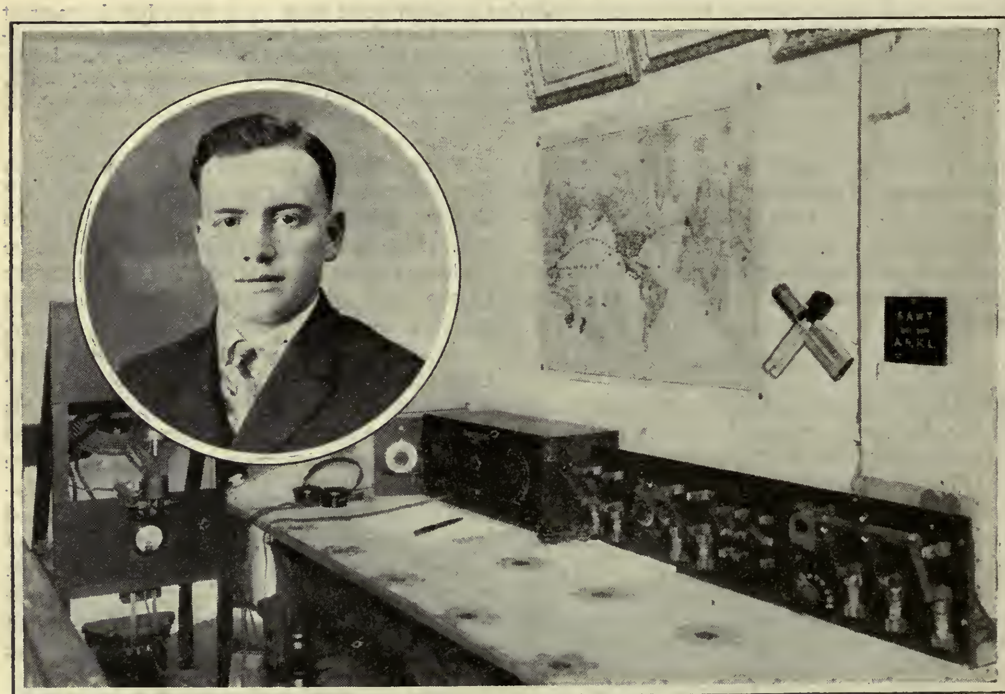
theory when he leaves as operator on Donald MacMillan's *Bowdoin* on June 15th of this year. Extensive experiments are to be carried on with daylight transmission on 20 meters while the ship is in polar waters. Mr. Reinartz as operator, has been appointed to the place held by Donald Mix aboard this ship on the previous voyage. Mr. Mix is also a member of the American Radio Relay League.

Both those appointments show beyond question the value placed on amateur talents.

For a number of years American amateurs worked with all of their might to send their signals across the Atlantic ocean. Their final success marked the real beginning of international amateur communication for it was not until that time that the future possibilities of low power and short waves were fully realized. Their next task was so to perfect their instruments and method of operation that they could exchange messages at will with private individuals in various foreign countries.

Immediately that two-way communication was established between amateurs on opposite sides of the ocean, interest of operators in this country reached a high state of enthusiasm and amateurs began to spring up here and there in countries where they had never been heard of before, until now they may be found dotting almost every part of the world. Three or four years ago American amateurs kept before them constantly a wall map of the United States, while now in these same radio shacks may be found world maps and globes.

With one kilowatt of power and a barrel of enthusiasm, amateurs threaten to conquer the three obstacles to radio communication, time, space, and daylight, using short waves that once nobody thought were of value.



THE WINNER OF THE HOOVER CUP FOR 1924

Bartholomew Molinari, owner of amateur radio station 6 AWT, San Francisco. The transmitter is one 250-watt tube, shown on the panel in the lower left. Note the wall map of the world, dotted with colored pins, showing the various parts of the world in which 6 AWT has been heard. Ten years ago, distance records such as these would have been considered an absolute impossibility

Making Radio Receivers More Selective

Practical Instructions on How to Improve the Selectivity of Various Popular Circuits in Use—A Clear Explanation of the Theory Involved in the Changes

BY KEITH HENNEY

THE problem that has been bothering many radio listeners recently, is one of the selectivity of their receivers. Mr. Henney, in this article, has discussed the whole question of selectivity. There is such a variety of circuits and sets to be considered when one tries to solve the problem of increasing the sharpness of tuning that a general consideration such as this, we think is the best way to help the individual. This is distinctly not a how-to-make-it article, but the reader will find all the necessary constructional information given. The individual can apply this information to suit his own problem. The suggestions here given are more in the nature of a remedy than a cure. The real cure for the situation lies in a re-adjustment of the broadcast transmitting situation. We believe that Mr. Henney's discussion of the theory involved here will prove very helpful to the radio constructor.—THE EDITOR

ACCORDING to the average radio listener, the flaws in the present scheme of broadcasting are two: the multiplicity of stations and the approach of "super-power." And in his peculiar dilemma of wanting to be in touch with all that goes on in the ether and yet to be exclusive, the listener must turn in but one direction, to increased selectivity.

Whether the problem is to doctor a receiver now in operation or to build a set that will be sufficiently selective, the questions that face the radio listener are the same:

What is selectivity?

How may it be obtained?

How much is necessary, or desirable?

WHAT IS SELECTIVITY?

SELECTIVITY is a relative term, and signifies the ability of a receiver to distinguish between several transmitting stations operating on frequencies that do not differ much from one another. To take an analogy from the phonograph field, let us suppose that the mechanism for recording music would respond only to those tones that lie between middle C and one octave above. Then no matter how many notes a pianist might play, the mechanism would record only those between the proper limits. In other words, the recording apparatus would be selective, and other tones would not bother it.

Broadcasting stations in Class B are now stationed 10,000 cycles apart. A receiver sufficiently selective will respond to only one station at a time. Frequencies 10,000 cycles different from that to which the receiver is tuned will not be heard to any marked degree.

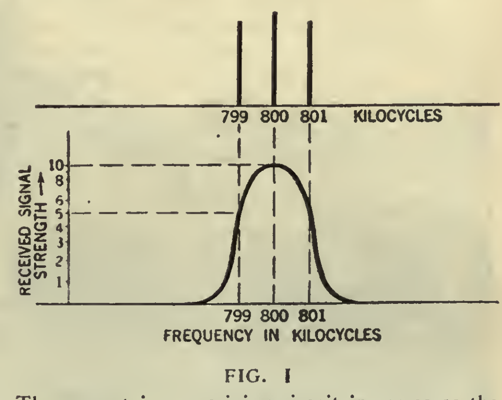


FIG. 1

The current in a receiving circuit increases as the resonance point is reached, as shown in this Figure. This receiver would be too sharp since it will respond to a band of frequencies only two kilocycles wide and would lose the higher musical notes entirely. A good receiver should have a resonance curve 10 kilocycles wide in order to get all of the notes broadcast from the transmitter

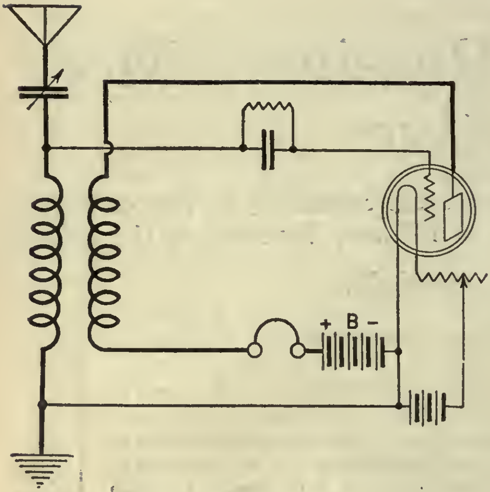


FIG. 2

This is the typical "blooper" circuit in which the antenna is closely coupled. This close coupling brings in the signals, but when the tube oscillates, it sends out signals as well—much to the discomfort of all near-by listeners

Fig. 1 is a resonance curve of a receiving set that will respond to a band 10,000 cycles wide.

Such is the ideally selective receiver.

How may it be obtained?

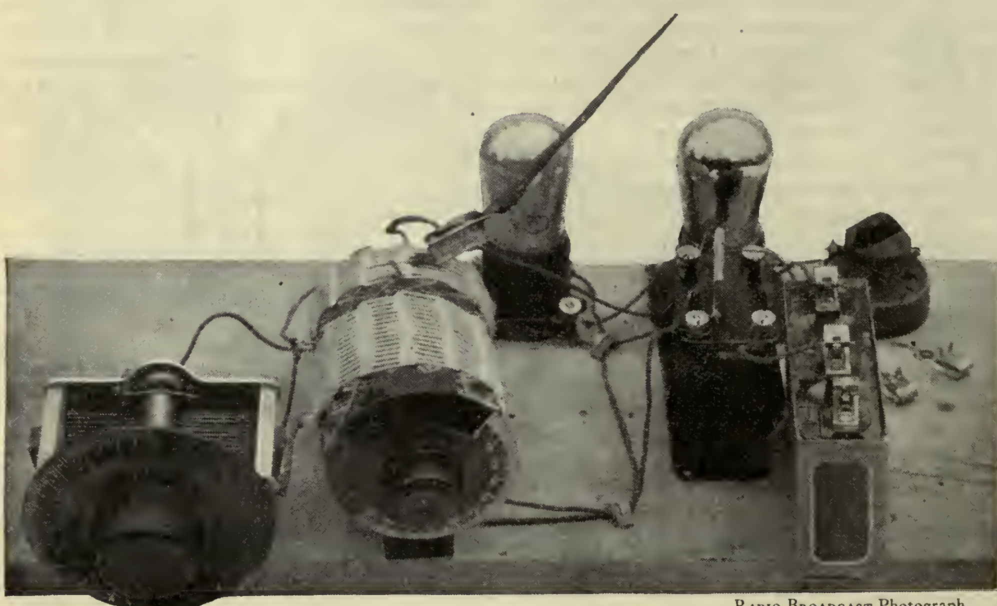
There is but one cause of poor selectivity—resistance, and the remedy is obvious: eliminate that resistance. This task, however, of separating the various resistances from a receiver reminds one of the adage of cutting off one's nose to spite one's face, for to remove all of the resistance would be to remove the receiver itself.

For the listener who builds his own receiving set, resistance is added through the use of long connections, poor coils and condensers, by placing coils too near large masses of metal, poor contacts, or by closely coupling a low resistance circuit to one in which considerable resistance exists.

The listener who owns a manufactured set must place his faith in the engineer who designed it and the factory that made it. There is little that can be done to the inner "works" that will better its tuning qualities. That little will be described in this article as well as the tricks that can be performed external to the receiver itself.

TO IMPROVE SELECTIVITY

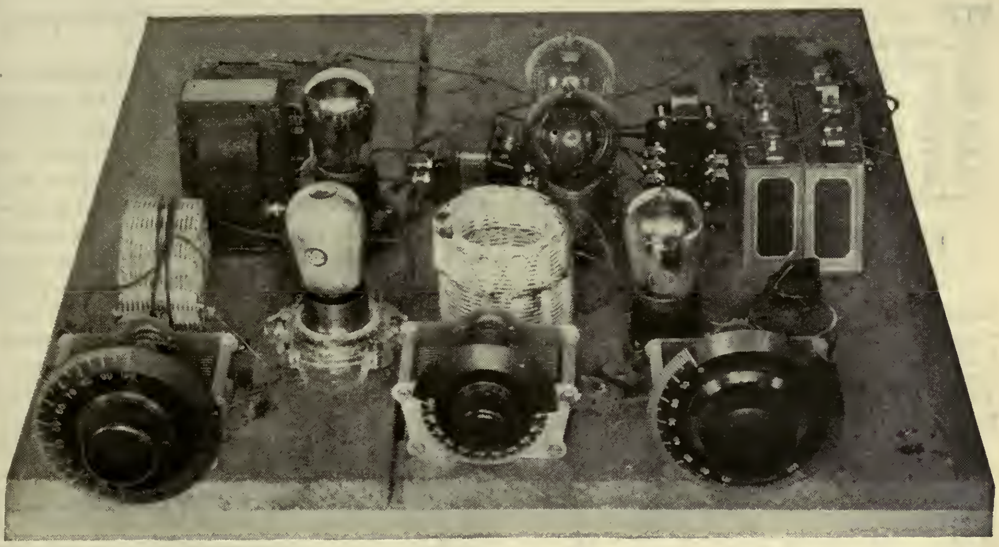
THERE are two general methods of improving selectivity. The first strikes at the cause, resistance. The second relies upon tricks such as placing obstacles in the path of unwanted signals, or of filtering out those that are desired and letting the others go where they will. In the latter method lie



Radio Broadcast Photograph

FIG. 3

A photograph of a single-circuit receiver in which the antenna is not actually connected to the detector but through another coil closely coupled to it. One stage of audio frequency amplification has been added. This is the nucleus of a good receiver such as shown in the photograph in Fig. 4



Radio Broadcast Photograph

FIG. 4

Here is a complete receiver built around the single-circuit blooper. The coil and condenser to the left compose the essentials of a radio-frequency amplifier, the second coil is the detector secondary and the amplifier plate coil coupled to it. The third condenser is for introducing regeneration in the detector. There are five tubes, three producing audio frequency amplification. The Pyrex socket is a good one for radio amplifiers due to its low losses

the wave traps and radio-frequency amplifier circuits.

In other words, we may eliminate the cause of poor selectivity—and there is a certain limit beyond which we cannot go in this direction—or we may force signals to go through a kind of maze through which those that are desired will emerge and in which the others will be lost.

IMPROVING THE SINGLE CIRCUIT RECEIVER

It is in the realm of the simple receivers, the bloopers and any set that employs no radio frequency amplification that the most can be done to sharpen the tuning. In Fig. 2 is the typical blooper circuit with its antenna closely coupled to the remainder of the circuit—a condition that broadens the tuning, and sends out into the ether the parasitic signals that condemn this type of receiver. Fig. 3 shows how simply such a receiver may be made and provided with one stage of audio frequency amplification.

The use of regeneration is a method of reducing an already existent resistance, and the ability of this simple receiver to go out and get distance lies in this resistance reduction —the same phenomenon that makes it a nuisance to all near-by listeners. An oscillating receiver is without doubt the most sensitive and selective, but its very sensitivity makes it unhandy. Small changes in the antenna system cause the oscillating frequency to vary with accompanying distortion.

The best possible addition to make to a blooper is a single stage of radio frequency amplification, an addition that increases its range, its volume, and its selectivity as well as eliminating its liability toward radiation. Fig. 4 represents such a circuit, together with appropriate audio amplifiers. The coils should be far apart and at right angles to each other, so that proper neutralization may take place. The photograph shows how simply such an amplifier can be made and clearly illustrates the proper placing of coils.

The amplifier plate coil may be made by winding ten or fifteen turns around the middle of the blooper secondary that is now used, forming the connection between the amplifier and the detector. The coupling between the antenna and secondary of the radio-frequency amplifier should be as loose as is consistent with good signal strength, and the same may be said of the coupling existing between the plate coil and the detector secondary. In Fig. 5 is shown the effect of close coupling, which is one of the best methods of adding resistance to a circuit and ruining its selectivity.

The effect of retaining regeneration in the detector is shown in Fig. 6 where the resonance curve becomes sharper and sharper

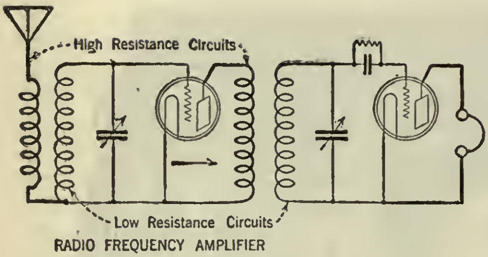


FIG. 5

Whenever a circuit of low resistance is closely coupled to a circuit of high resistance, it tunes broadly. In other words some of the high resistance has been "reflected" into the low resistance. The solution to this trouble lies in separating the two coils as far as is consistent with signal strength

with the result that near the oscillation point, the quality goes bad.

With the addition of such an amplifier to a blooper, the listener now has the advantage of decreased resistance due to regeneration but the added feature of a wave trap in the antenna circuit. All signals must pass the tuned circuit consisting of a coil and a condenser before they can get to the detector, and before that happens they must also pass through the vacuum tube which boosts their voltage by at least six times. The wave trap sharpens the tuning and additional tuned circuits may increase still further the narrowness of the received frequency band, but the trap itself does not add voltage; this is the function of the tube. These facts are shown in Figs. 7 and 8.

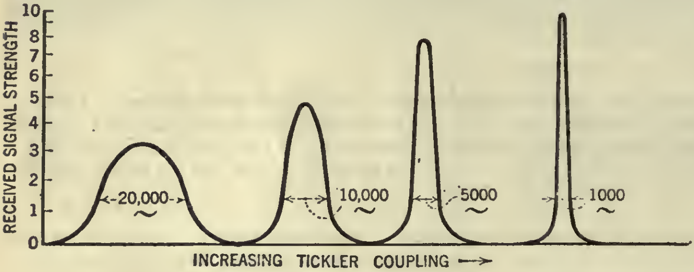


FIG. 6

According to most authorities, regeneration is a means of reducing the resistance in a circuit. It is accompanied by sharp tuning, and the more regeneration that is used, the narrower is the frequency band taken in by the circuit. Near the oscillation point, the circuit may become so sharp that "side bands" are chopped off and poor quality results

WAVE TRAPS

IF THE listener does not care to add another tube, or if he already possesses a stage or two of radio frequency amplification, he may use the coil and condenser of Fig. 3 as a "wave trap," and provided that they be of low resistance, he will be able to cut his path through interference with greater ease.

Wave traps, in general, are of two kinds: those that are shunted across the antenna and ground and called "acceptors," and those that are in series with the antenna and ground which are called "rejectors." A rejector prevents one frequency from getting into the receiver, but lets all others pass; in other words, it cuts a slice out of the stations that are on the air. An acceptor provides a convenient by-pass for all frequencies but the one that the listener desires to hear.

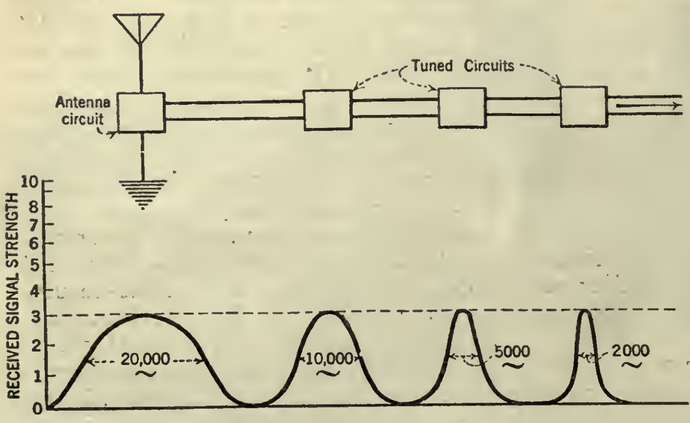


FIG. 7

A coil and a condenser are the requisites of an obstacle to put in the path of a radio frequency current. Such a device, if properly used, may sharpen the tuning because it must be accurately tuned before any energy can get through. Two or more increase the selectivity because nothing gets through until each obstacle is tuned correctly

The wave trap is simply a good coil and a good condenser connected and placed in some part of the antenna-ground system. The trap used in Radio Broadcast Laboratory

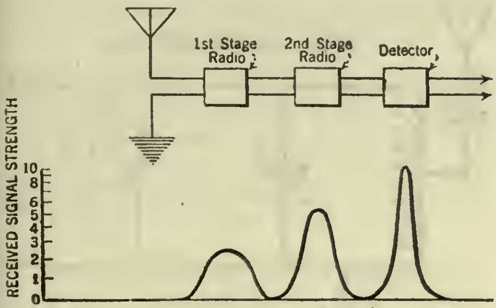


FIG. 8

A radio-frequency amplifier not only acts as a trap for unwanted signals but boosts the voltage of the one signal desired. In this Figure, the effects of adding several stages of tuned amplification are illustrated. Each additional stage cuts down the width of the frequency band that is passed and increases the voltage

and shown in Fig. 9 consists of a General Radio .0005 mfd. condenser, across the terminals of which is shunted a low-loss inductance coil. Around the coil were wound several turns of wire, and it is these turns that are inserted in the antenna-ground system. Any good coil and condenser that will cover the frequency range may be used. The receiver shown in Fig. 9, then, consists of a single circuit blooper with a wave trap to sharpen the tuning and cut down interference and a Samson 3-1 transformer to provide additional volume. Fig. 10 shows in a schematic manner the connections of a wave trap.

Various methods of connecting the trap to a receiver now in use are shown in Fig. 11. When in series with the antenna, as in A or C, they may be set at the wavelength of some interfering station. That station will not interrupt until the tuning of the trap has been changed. When across the input to the receiver, as in B or D, a trap will let into the set only the signal that is desired, and make tuning somewhat more complicated. On the other hand, once the listener becomes accustomed to the tuning, he will find this type of considerable value.

Two traps may be used, one tuned to some particular station and thereby eliminating its signals, and the other adjusted along with the tuning of the receiver itself, as is illustrated in E, Fig. 11.

A wave trap will not increase signal strength; it will work well only with a receiver in which the antenna circuit is completely or partially tuned; it will perform its duties only if low

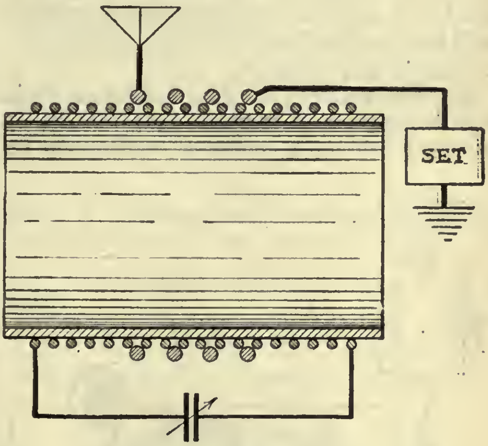
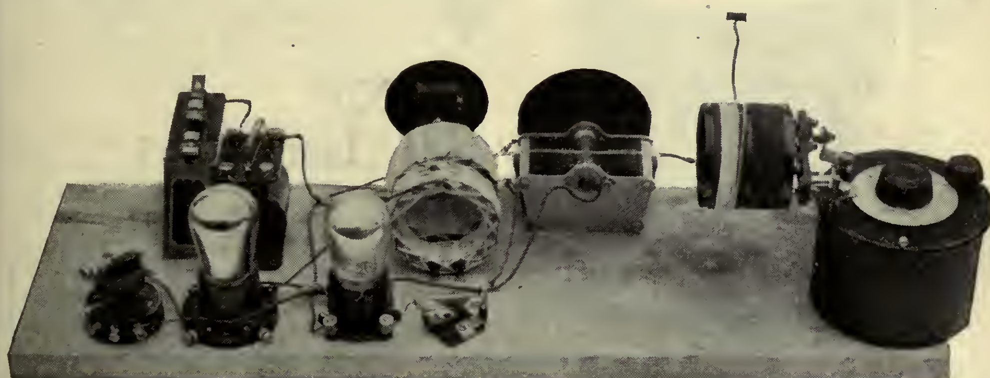


FIG. 10

The connections of the wave trap shown in Fig. 9. The coils and condensers in such a device should be of low resistance to make the tuning sharp



Radio Broadcast Photograph

FIG. 9

A simple wave trap consisting of a coil shunted by a condenser is inserted in the antenna circuit by means of several turns of wire wound around the coil. This is then a "rejector" since it rejects one frequency that is unwanted

resistance parts are used; and will not be of value to the more complicated receivers of the radio-frequency amplifier type.

On the other hand, a wave trap will be a boon to the blooper, to the two-, the three-, and the four-circuit receivers; for it will cut a slice out of the ether where there is some interfering station, and it will stiffen up the tuning of the antenna circuit considerably.

The coil and condenser shown in Fig. 9 may be calibrated in wavelengths or frequencies and used as a measure of incoming waves, and it need only be placed near one of the coils of a receiver, be it a blooper or a five-tube affair, to indicate the frequency of incoming signals. When the condenser is tuned, a marked decrease in signals will be noted, and if it is used with an oscillating receiver, a sharp click will be noted in the phones when passing the frequency of the signal.

For this purpose, the additional winding is not necessary and the unit then consists of simply a coil and a condenser, which may be calibrated either in wavelengths or frequencies by noting where several well known broadcasting stations are tuned. A curve may then be plotted showing the relation between condenser setting and wavelengths or frequencies.

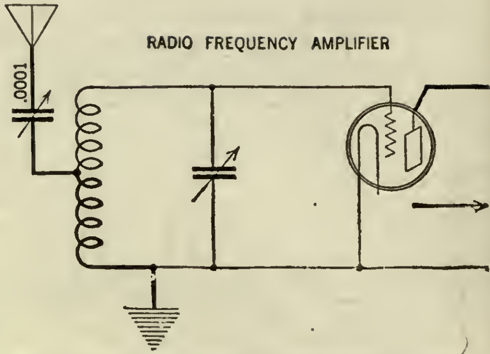


FIG. 12

A simple method of increasing selectivity is illustrated in this Figure. The condenser may be variable, but after the correct place to tap the coil is found there is no need for further adjustment

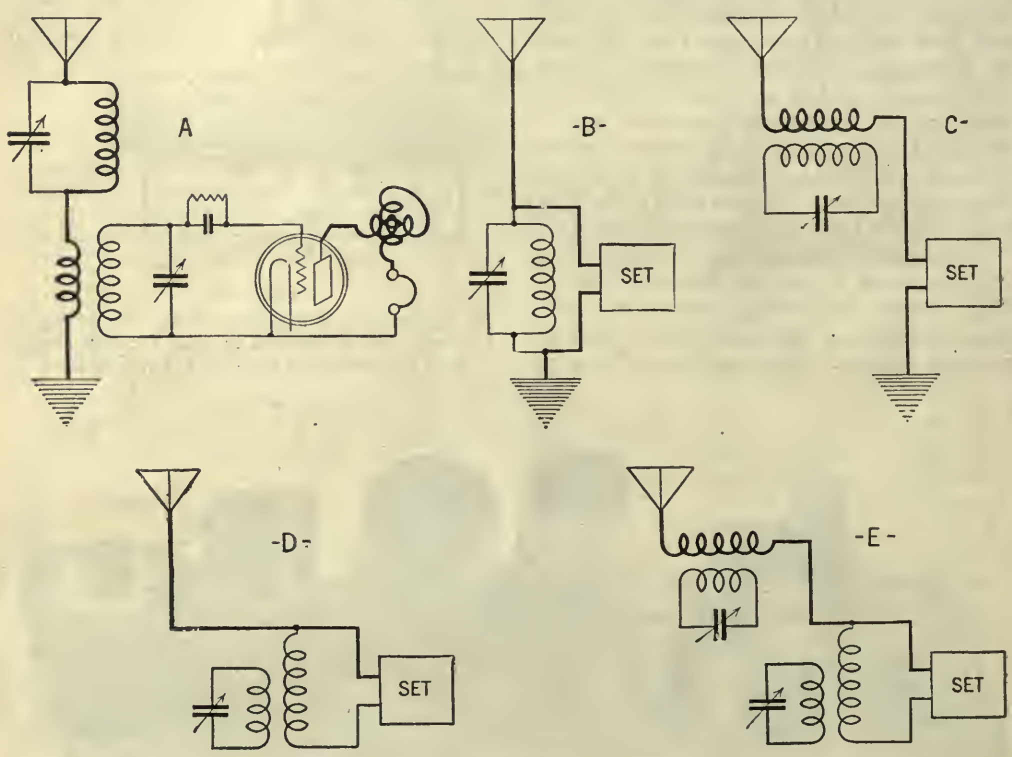


FIG. 11

Wave traps are really simple devices, consisting of a coil shunted by a condenser. But to be effective, both of these component parts must be of low resistance. In this Figure are shown several methods of connecting such a trap to the antenna circuit of a receiver. They are useful only if the antenna is partially or completely tuned, and will not do much good when used with a complicated receiver. With the simple circuits, however, they will enable the listener to cut out unwanted stations, and to sharpen the tuning of his receiver

RADIO FREQUENCY AMPLIFIER-REGENERATIVE DETECTOR RECEIVERS

IN RECEIVERS such as the Roberts Knockout, the Browning-Drake, the Teledyne, and others of similar nature using a regenerative detector with one or more stages of radio frequency amplification, there are several things that may be done to improve the overall selectivity.

The series condenser in Fig. 12 is a potent device for sharpening tuning, especially since regeneration in the detector makes up for any loss in signal strength resulting from the insertion of this condenser.

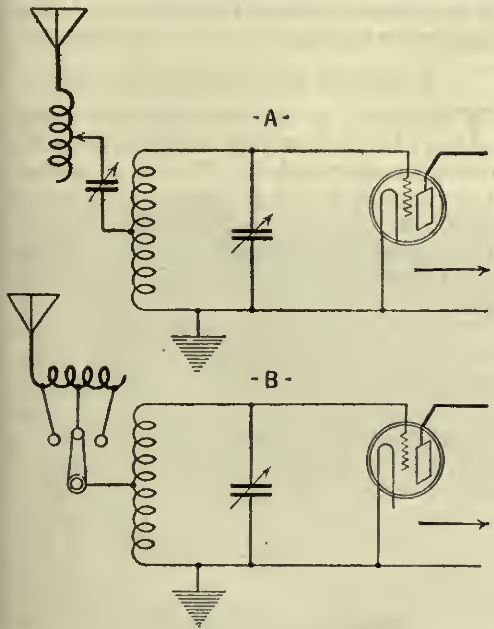


FIG. 13

Adding an inductance coil to the antenna circuit and partially tuning it by taps or completely tuning the circuit by a variable condenser will add to the ability of the receiver to select the signals a listener wants. The coupling to the receiver may be decidedly loose if the antenna is carefully tuned by means of the variable condenser

Another method was described in RADIO BROADCAST for April in the article on experiment with the Roberts circuit. This is the addition of inductance in series with the antenna and partial tuning by means of taps, or complete tuning by means of a variable condenser. Fig. 13 illustrates both methods.

Loose coupling between the antenna coil and the secondary of the amplifier and the two coils connecting the amplifier and detector is necessary for the sharpest tuning, as shown in Fig. 5. This feature is embodied in several coils now made for the Roberts receivers.

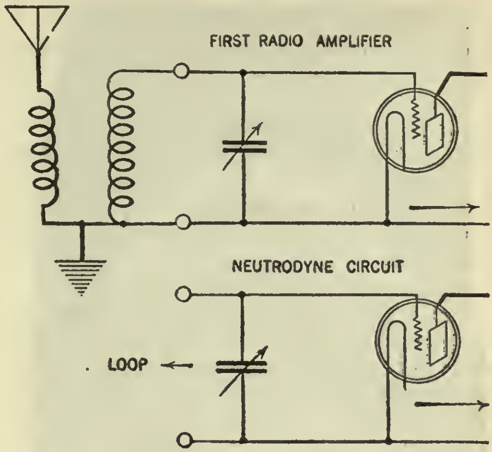
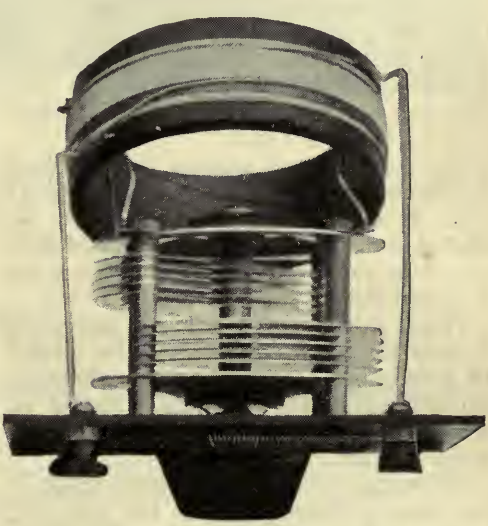


FIG. 14

The use of a loop in place of the first coil of a neutrodyne presents few difficulties, especially when it is to be used on local stations. The loop should have the correct dimensions so that it will take the place of the neutrodyne coil that is removed. The loop will provide a decided increase in selectivity due to its directional effect, but of course will cut down signal strength

THE NEUTRODYNE

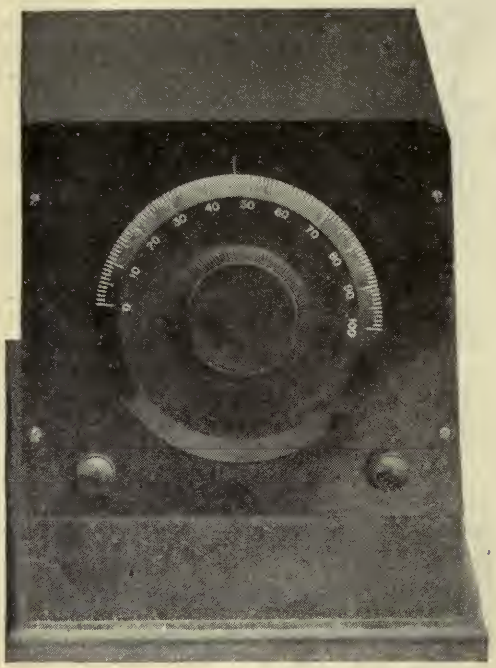
THE two stages of radio frequency amplification of the neutrodyne are simply so many wave traps, each making the band of



RADIO BROADCAST Photograph

FIG. 15

The "inner works" of a wave trap used in RADIO BROADCAST'S Laboratory. The conventional coil and condenser are well illustrated as well as a method of mounting them



RADIO BROADCAST Photograph

FIG. 16

The outward appearance of the wave trap illustrated in Fig. 15. This makes a neat-appearing addition to any broadcast listener's equipment

frequencies that is finally passed into the detector, sharper. For this reason a neutrodyne should be very selective. There is the additional advantage in the tuned radio frequency circuits that each vacuum tube adds a certain amount of amplification, so that there is a gain in volume as well as in select ivity, as shown in Fig. 8.

The use of a small antenna is advisable if interference is to be cut to a minimum. If space is available, two antennas may be erected at right angles to each other and their directional properties used in cutting out unwanted stations.

Proper neutralization is highly important in those receivers using the Hazeltine scheme of stabilization, and in the potentiometer-stabilized sets, this instrument should be used as far as possible toward the negative end of its scale.

Often the addition of slight regeneration in the detector circuit is helpful, but a receiver with two stages of high-frequency amplification is a bad place to add a tickler. The whole system is liable to howl.

Much will be gained by the use of a loop instead of an antenna, or even in place of the first coil of a neutrodyne. This is especially true when there are powerful near-by broadcasting stations. Fig. 14 shows how the antenna loop may be substituted for the antenna coil and secondary of the first amplifier.

The scheme illustrated in Fig. 11, in which a small condenser, say about .0001 mfd., is placed in series with the antenna, may be applied to the neutrodyne. This tends to loosen the coupling with the antenna and to prevent its high resistance from getting into the amplifier. It has the disadvantage that it may cause somewhat weaker signals and change the readings on the first condenser.

IMPROVING THE SUPER-HETERODYNE

THERE is no receiver available to-day that has the potential sharpness of tuning of the super-heterodyne. Here is an oscillating circuit, in itself a maximum of selectivity; here are two or more intermediate circuits through which the signals must pass before being heard; here is a low-resistance energy collector, a loop.

There is little that can be done with a "super" that is already in operation. Methods of adding regeneration to a loop have been described in RADIO BROADCAST. If an external loop is used, the listener should make sure that it is of low resistance, not placed near any metallic objects, such as a radiator, or wall of a steel-lathed room or a steel building. If there are taps, they should make good contact.

A good loop is directional, that is, it receives better when pointed in the direction of the transmitting station. Full advantage should be taken of this tuning aid by the proper use of a compass fixed to the base of the loop.

HOW MUCH SELECTIVITY?

THE question finally faces the listener of how much selectivity is necessary or desirable. Broadcasting stations transmit into the ether a band of frequencies about ten thousand cycles wide, these frequencies being distributed on either side of a single sharp "carrier wave." Theoretically, all that is required for clear reception, is the carrier wave and one of the two "side bands," which would require a receiver with a resonance curve only five thousand cycles wide. Practically, it is difficult to make coils with low enough resistance that the resonance peak will be less than ten thousand cycles wide, and if this sharpness is secured the listener will have no difficulty in separating Class B sta-

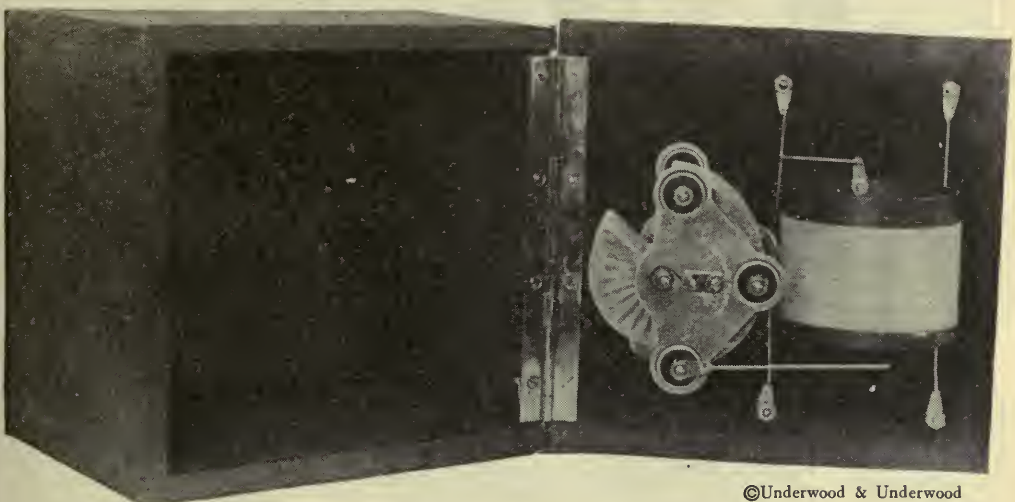
tions—provided that they stay on their allotted frequencies.

Regeneration decreases the width of the resonance curve, and when it is pushed too far the higher audio notes begin to drop out, producing considerable distortion.

There is a scheme that might be tried on super-heterodynes that will bring in any station that happens to be transmitting with quality sufficient so that the announcer may be understood—but music will be pretty badly distorted. This scheme consists in placing a band filter in the receiver passing only frequencies between 1,000 and 2,000 cycles. This will make tuning so sharp that little interference will be experienced and many of the low-frequency spurts of static and noises will be eliminated.

Since the voice frequencies that carry intelligibility lie above 1000 cycles, such a filter would let through speech that could be understood, although entirely unnatural.

The band filter is really two wave traps in series, one cutting off all low frequencies and the other cutting off the high ones. If their cut-off frequencies are close enough together they will let pass a narrow band of frequencies, and this band of frequencies can be made as wide or as narrow as is necessary to get the required selectivity. Since the frequencies dealt with in this double wave trap are audio frequencies, large coils and condensers are required, and the proper design of these coils depends on measurements which cannot be made by the average radio constructor.



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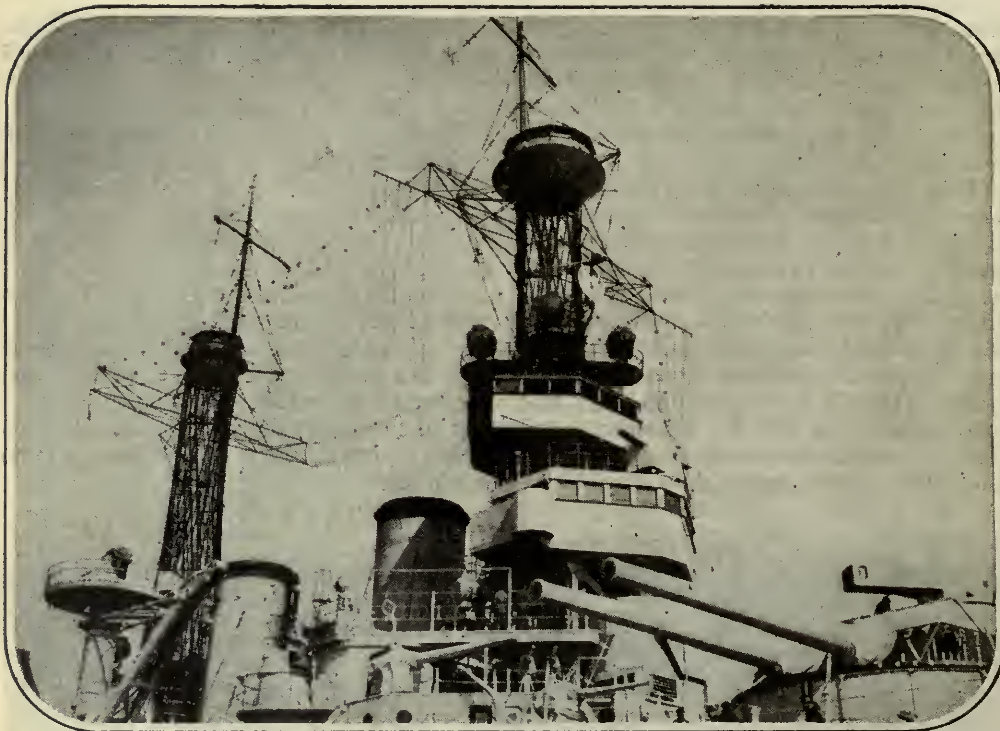
A WAVE TRAP IN A CABINET

Interior view of a wave trap using a Heath radiant condenser and a coil, which can be wound by the constructor. The simplicity of construction is obvious. The overall size of this cabinet is 8 x 7 x 5 inches

HOW TO MAKE A DETECTOR AND TWO-STAGE AMPLIFIER UNIT

A REMARKABLY efficient radio-frequency amplifier unit was described by John B. Brennan in the May RADIO BROADCAST *which has made a great appeal to many constructors who wanted to build such a unit using the most advanced ideas of construction. In an early number of* RADIO BROADCAST, *Mr. Brennan will describe the construction of a detector and two-stage audio amplifier. The unit is quite as compact as the radio-frequency one. The general experimenter will find the detector-amplifier unit of excellent service in testing out intermediate amplifier, tuned radio frequency, and other circuits. This unit is easy to build, it is well made and substantial and incorporates some excellent constructional features.*



THE U. S. S "ARKANSAS"

With her battery of big guns and radio antennas. At least seven separate antennas can be seen in the picture. All the Naval radio communication is carried on in the longer wavelengths with cipher codes. The larger ships have complete radio telephone equipment, which is chiefly used for communication between ships over short distances

THE MARCH OF RADIO

By J. H. Morecroft

Past President, Institute of Radio Engineers

Why Does Congress Refuse to Broadcast Its Proceedings?

WE ARE wont to give ourselves credit for being the most modern and progressive of people, and in the same breath affirm that the English are the most conservative, and that their excessive caution not to upset the accepted customs and methods of procedure effectually prevents progress. And of all the conservative bodies of statesmen in the world we have readily granted that Parliament was the most striking example.

Imagine then, introducing a new and novel instrumentality such as radio into the Houses of Parliament. Yet Prime Minister Stanley Baldwin announced recently that he contemplated creating a committee of members of both Houses to consider the question of broadcasting the proceedings of that ancient and honorable body.

Are we going to let our conservative friends show us the way?—or shall we introduce radio broadcasting as a part of Congressional

procedure at once, before Parliament gets the "air"? It would appear from past news stories that many congressmen seriously object to having their oral activities spread out over the countryside where their constituents might be listening to their speeches. Can we suppose that the filibustering tactics, which have successfully blocked constructive legislation in the past as a result of petty partisan politics, could be carried out if several million healthy Americans were listening-in? Probably not. It would take more nerve than the average senator has, to get on his feet and read for hours senseless nothings for the *Congressional Record* with the idea of blocking some measure which millions of his listeners might want. He would get much worse than "Helen Marias" in his morning's mail, we imagine, and it would probably be unnecessary for Vice President Dawes to advocate changes in senatorial procedure.

We broadcast political conventions because, we now know, the people are intensely interested in the methods of governmental procedure, as well as in the men chosen to run for office. But we might well ask: What is more important, to know who is chosen to run for office or to know what he does after he gets in? Assuredly the activities of Congress are of more importance to the average citizen than are the proceedings of the national conventions. Let us then broadcast the proceedings of our congressmen, whether they will or no. The nation has certainly the right to demand the privilege of hearing its elected representatives perform in office. Fewer words would be used and much more government business would be transacted, we venture to prophesy. As the most probable man to act, we appeal to General Dawes to father the movement. Were this sponsoring to occur we are sure he would be no longer concerned with senatorial procedure and that incomprehensible political cross-word puzzle would soon solve itself.

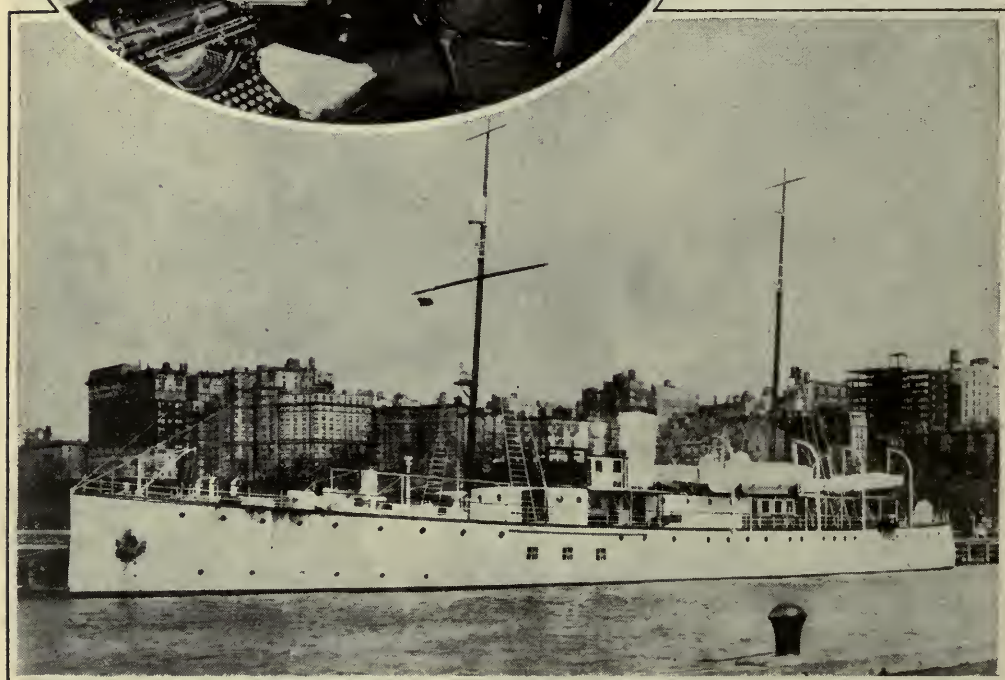
RADIO EQUIPMENT FOR THE HOTEL

Among the many hotels in the country to install radio service for guests is the Biltmore, in New York. Individual receivers are used with A and B supply and loud speaker all contained in one cabinet. An attendant is tuning the receiver for Marion Benda (left) and Mary Mulhern, musical comedy actresses

When Radio Aided Politics

THE service of radio to the public has been frequently analyzed and generally much over-estimated. The number of radio listeners is generally given as several million more than it is, with the idea of lending color to the news. Without exaggeration, however, it may now be stated that radio has really helped millions in at least one state. This help was not only in culture and entertainment, but it can be measured in real dollars and cents.

Governor Smith of New York State was actively working for the passage of an income tax reduction of 25 per cent., but the majority of his legislators, being of different political faith, were doing their best to thwart his plans. Probably had they thought at all (which is questionable) they would have been in favor of tax reduction themselves, if the reduction could have been pointed out as a Republican measure. But never must a Democrat be allowed to get credit for such a universally desired piece of legislation. So the tax measure seemed well on the way to be defeated by petty politics. From the Republican point of view this probably seemed a happy idea, for since they were in the majority, they could control the distribution of



THE S. Y. "ARA"

Owned by William K. Vanderbilt. The ship is lying in the Hudson River, off Riverside Drive with some apartment buildings of upper New York in the background. The radio equipment of the *Ara* is very complete and equals that of the largest express liners. The interior of the radio cabin is shown in the insert. On the left is the $1\frac{1}{2}$ kilowatt c. w. transmitter, next is the radio compass equipment and then the receivers for long and short waves. A $1\frac{1}{2}$ kilowatt quenched spark damped wave transmitter and a $\frac{1}{2}$ kilowatt emergency set complete the elaborate equipment of station KFBO. The operator is using a double speed key, known among operators as a "side-wheeler"

EXHIBIT "A" FROM THE RADIO AMATEUR

A display that speaks for itself which was one of the exhibits at the recent radio show held by the amateurs of the Second United States District

the vast sums which the unneeded taxes would bring in.

The upstate press which is largely Republican, carried very little, if any, material which might make their readers think well of the Democratic governor, and probably most of the voters who read those papers thought him an impractical visionary, but he wasn't one, and the petty Republican politicians soon discovered that even with their influenced press the truth could not be kept from their constituents. Governor Smith decided to talk over the radio directly to the taxpayer, be he Democrat or Republican. "Al" Smith did talk and, so effectively did he place his arguments before the people of New York State that the Republican majority were forced to accede to him and pass this legislation which the people wanted. That is a real service which helps to weed out the petty, self-seeking politician and expose his actions to the sight of millions of those he is supposed to represent. Then indeed has radio the right to be counted as one of the important factors of our economic life.

The Tangled Broadcast Situation

THE press recently featured interviews with such well-known radio men as Professor M. I. Pupin of Columbia University and Arthur Batcheller, the Supervisor of Radio for the Second District. The subject of the interviews was the ever increasing number of stations coming on the air. "We are at the end of the rope," says Mr. Batcheller. "The ether has reached the saturation point for broadcasters." Now if any one really knows about the situation it probably is Mr. Batcheller. He is the Government's representative in the most congested radio district in the world, and from morning to night he has to listen to radio troubles. In the opinion of Professor Pupin, "licenses were granted in the beginning without any discrimination,"—and we would add that such a policy still seems to control the issuance of licenses.

A strange instance of the attitude of the Department of Commerce on this jamming of the ether was recently reported from Cincinnati. Two stations in that city had been granted licenses to operate on the same wavelength, and after much squabbling as to a division of time they finally did operate on the same wavelength and at the same time! It was reported from Washington that the Department of Commerce had been repeatedly asked to step in and settle this impossible situation, but had declined on the ground that "to set such a precedent would get the Department hopelessly enmeshed in a maze of disagreements between stations." One might well ask the Department how it did expect

such disputes to be settled? It is a strange idea of privilege and duty which consents to the issuance of broadcasting licenses to any who want them and then when trouble comes to the listening public as a result of the excessive number of stations, to turn one's back and let someone else settle the trouble when that trouble was directly due to the Department's freedom with licenses. Who, we also again ask, does Mr. Hoover think will step in to straighten out trouble between various stations if his department thinks the task too onerous?

Let us venture again the proposition that licenses be refused to a new station unless the request is accompanied by a petition signed by a reasonable number of prospective listeners. The more we consider this idea the more it appeals to us as a sensible method of controlling the number of broadcasting stations in the interest of the listening public.

The Navy Establishes an Amateur Radio Reserve

CAPTAIN RIDLEY McLEAN, Director of Naval Communications, has conceived the idea of increasing the effectiveness of the Naval Reserve Force by enlisting in its personnel the radio amateurs of the country. During the World War, much time and effort were spent in training a staff of radio operators and technicians; several schools had to specialize in such work because, at that time, there was a great demand for radio communication, both on sea and ashore.

Hiram Percy Maxim, President of the American Radio Relay League, has sent out a call to all members of his organization to file certificates of willingness to join the Naval Reserve. Such enrolled amateurs will receive instruction in the use of Naval radio equipment, so that in any emergency the active radio personnel of the military organizations can be at once increased to its proper complement. It is expected that possibly 6000 amateurs will respond to this call. We regard this move as an exceptionally desirable one on the part of the Navy. There is much talent among American amateurs which can be used to good advantage by the Navy.

The Month in Radio

EVERY month brings with it some patent decision in the radio field. There are so many suits being waged to-day that it would be strange if the month did not record some decision or other. As to who was the real inventor of the regenerative circuit, generally credited to Armstrong, seems yet to be a mooted question. The fortunes of legal war pass back and forth, and it appears that a recent decision of Judge Learned Hand, having to do with the possibility of a suit against the De Forest Radio Company, shows the tide of battle turning in favor of the De Forest Company. However, we cannot pretend to understand all the legal complexities and ramifications in these patent suits, but we note, in passing, that neither litigant seems to have received a knock-out blow up to this writing. They are both still in the commercial running.

IN SOME preliminary tests having to do with equipping army planes for summer maneuvers, it was found feasible for pilots in different machines to converse with each other when they were in full flight, and as far as five miles apart. This seems like a very short distance to us who nightly hear concerts a thousand miles away, but it is to be remembered that the power output of the airplane transmitter is necessarily low and the difficulty of receiving is enormous because of the excessive noise caused by the powerful motors exhausting almost in one's ear and the hurricane rush of the wind as the plane speeds through the air faster than two miles a minute.

IS THE radio market saturated? Every time a temporary falling off of sales occurs, this question is brought up. It seems that conservative estimates place the number of receiving sets in the United States at about 3,000,000 and on this basis we surely can guarantee the radio manufacturer a fruitful market for some time to come. Certainly as many people should own radio sets as at present own automobiles and phonographs and each of these numbers close to 15,000,000. Because of the lower cost of radio sets it would not be unreasonable to estimate the saturation point for radio receivers considerably higher than that for automobiles and phonographs. Our belief is that the market will keep on absorbing radio sets until there are about 20,000,000 in use.

WHEN Donald B. MacMillan departs again for the polar regions the latter part of this year his radio outfit will be primarily designed to use short waves. His experiences with radio during his last expedition, as well as his recent conferences with radio experts here, have convinced him that

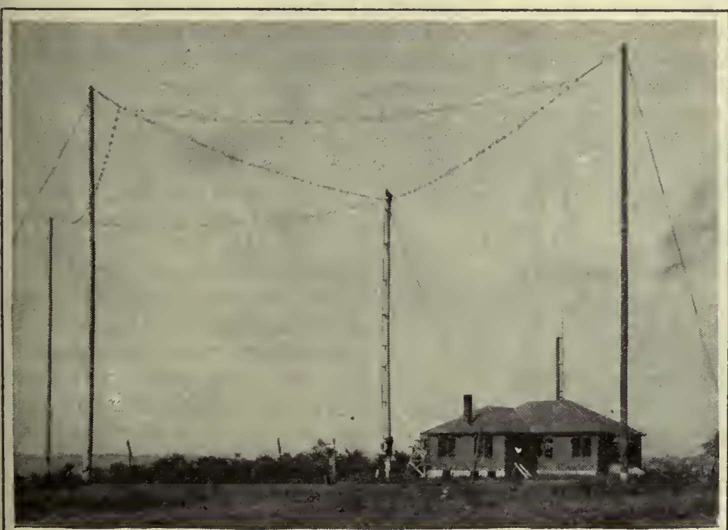
the short wave channels will prove more reliable than the longer wavelengths used by broadcasting and commercial stations. So, if you want to hear news from the North Pole next winter, have one of your amateur friends build you a receiver for tuning to waves as low as 20 meters and then listen for MacMillan.

THE Turk has decided to modernize himself as far as radio is concerned, and the Radio Corporation of America seems likely to get a contract to build a huge station at Angora. The former station there was of German construction and, according to the press dispatches, it is not suitable for transoceanic traffic. It will probably be repaired and modernized sufficiently to carry on whatever European traffic may originate at this point.

THE Navy has put the airplane and radio to a new service in which they prove to be valuable aids in naval maneuvers. The modern gun has such a range that the target may be out of sight, or at least so far away as to make visual observation extremely unreliable. By having an observer equipped with a radio telephone in an airplane hovering over the target, the fire control officer on board the warship is at once notified of the accuracy of his fire. This method of control, using two-way communication, is so rapid and accurate that proper corrections can easily be applied to successive broadsides without interfering at all with the rapidity of fire.

FROM the radio research laboratory of the Soviet Government at Nijni Novgorod comes news that the workers there are perfecting a water-cooled triode tube. Apparently the scientific workers, or their press representatives, are going along the same independent lines of endeavor as are their experimenters in the fields of economics and sociology. Could they but profit by the experience of others they would find that the triode being "developed" there had already been developed successfully here quite some time ago.

THE Senate has just authorized the continuance for two more years of the private use of Pacific Naval Radio stations. The Department of Commerce recommends this use of the Government's stations, for it is their opinion that the private stations on the west coast are not now in a position to undertake efficiently the transmittal of all the commercial



THE EXPERIMENTAL SHORT WAVE ANTENNA OF KDKA

At East Pittsburgh. The high wooden poles to which the fan antenna is attached forms the experimental 309 meter antenna from which regular programs are radiated. The shorter vertical pole above the roof of the building is the short wave antenna. The oval at the right shows a close-up of the short wave transmitting antenna. Note how short the actual antenna is and that the conductor itself is rigid. Rigidity of the antenna conductor is absolutely essential where very short waves are being transmitted. Signals from this short wave station have been recently heard in Australia, a distance of about 11,000 miles from Pittsburgh

JOSEPH C. SMYTHE AND ANTHONY GERHARD
Both of New York City who won the awards of the Executive Radio Council of the Second Radio District for commercial radio code speed proficiency. Mr. Gerhard copied 56½ words a minute without an error. It is almost impossible to send the Continental code by hand at such a speed and the achievement of such a record is remarkable

and private messages which are being sent to-day. "Continuation of the service by the Navy is necessary," says Senator Jones (Rep., Washington), "because the private agencies have been unable so far to complete construction of facilities and handle all the messages.

The Progress of International Broadcasting

FREQUENTLY the press tells us that the programs of KDKA and other American stations have served for operating the English stations, thus giving our English friends the same programs as we were listening to. Never has this been accomplished, however, in the reverse direction. It seems more difficult for us to receive a European station than for them to hear ours. A short time ago, however, a start was made which at least shows us the difficulties encountered.

The Radio Corporation station, WJZ, has on several occasions lately been actuated by signals received from 5XX Chelmsford, England. The transatlantic signals were sent across the water on a 1600 meter wave to Belfast, Maine, and from there rebroadcast on a 112 meter wave and picked up by the Radio Corporation's experimental laboratory on the outskirts of New York. From that point the signals went by wire to control station WJZ.

So the movement for transatlantic broadcasting, started by RADIO BROADCAST in November, 1923, has gone on. First by KDKA sending its signals to control 2LO in London and now we have our stations controlled by signals emanating from London. To be sure the reception of the London program here was so poor that the encounter must be recorded as a victory for Static, but it is a beginning and we can expect to hear the chimes of Big Ben with ever increasing distinctness and faithfulness of reproduction.

Transatlantic Telephony Is Not Yet

IN HIS recent annual report, H. B. Thayer, Chairman of the Board of Directors of the American Telephone and Telegraph Company, reviewed his company's attitude toward radio development.

"In view of the great public interest in wireless telephony, it seems proper to mention the continued preparation of the British Post Office for transmission from Great Britain. When that is completed it is expected that the experiments referred to in the annual report of 1922, will be resumed, and that experimental conversations with this country will follow. It is impossible at present to predict the date of telephone conversation with Great Britain or even to predict, on the basis of present conditions, that it will be a practical and commercial possibility, taking into consideration other difficulties. Any other applications of wireless telephony to telephone service, except in minor instances where wire connection is impossible, appear even more remote."

When Trains Are Run by Radio

WHEN an engineer is giving a technical talk to laymen not well acquainted with the field being analyzed, he is very likely to make statements that will appeal to the imagination of his listeners. With the

idea of gaining their attention and interest, he is likely to venture much farther than he would if talking to a number of fellow engineers. We therefore take with a grain of salt a prediction of Mr. G. Y. Allen, of the Radio Department of the Westinghouse Company, given in a talk before the New York Railroad Club. After telling of the possibility of guided radio waves, that is, high-frequency current over wires, Mr. Allen went on to tell of the uses to which such currents could be put in railroad operation. "It is entirely feasible," said he, "through a combination of electric controls, and radio supervisory control, to start a train without a crew from a station, run it at full speed over clear tracks, and to slow down and stop it automatically in accordance with automatic block signals, giving to a central despatcher at the same time complete supervisory control of all of the movements of trains on a system."

Certainly all these things are possible, for it was only a short time ago that a warship was completely controlled in its course by suitable relays actuated by means of radio signals. But just as our warships still require crews of more than a thousand men to handle them, so our trains will, for quite some time to come, require the crews to which we are accustomed. For the time being, we prefer to have a train controlled by an experienced engineer rather than by a fraction of a watt of high-frequency power which, as we all know, may have all of its good intentions seriously interfered with, and possibly thwarted altogether, by static and other disturbances.

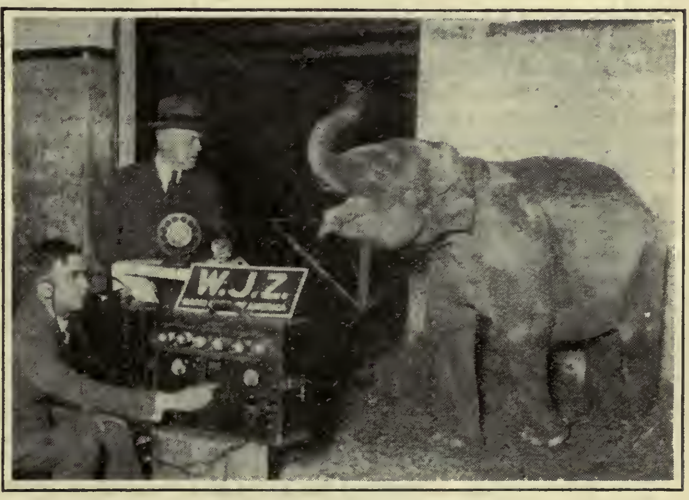
More Facts About Radio Transmission

EVER since Marconi's first transatlantic experiment, attempts have been made to explain the difference between night and daylight transmission, the effect of wavelength on the distance a signal could travel, the reason for the difference in receiving between summer and winter, and many other observed facts. With the ever increasing use of short waves, we are more than ever convinced that much of our supposed knowledge of how radio waves are propagated is not based on fact. Waves 100 meters long should theoretically travel but a short distance before being dissipated, but in spite of this, they, at times, reach half way around the world.

Two of the engineers of the Bell Telephone Laboratories, W. H. Nichols, and J. C. Shelling, recently published a preliminary note on some theoretical work they are carrying out. This note states that, due to the combined effects of the ionized (electrified) upper atmosphere and the earth's magnetic field, peculiar effects on radio wave propagation may be expected. The theory, logically based on the known behavior of electric charges moving in magnetic fields, seems capable of explaining the remarkable fading and bending to which we well know the average radio wave is subjected. Possibly even the peculiar effects noted during the January, 1925, eclipse would prove explicable in the light of this new analysis. Dr. G. W. Pickard has just presented an interesting paper before the Institute of Radio Engineers, giving his findings on radio transmission during the recent sun's eclipse.

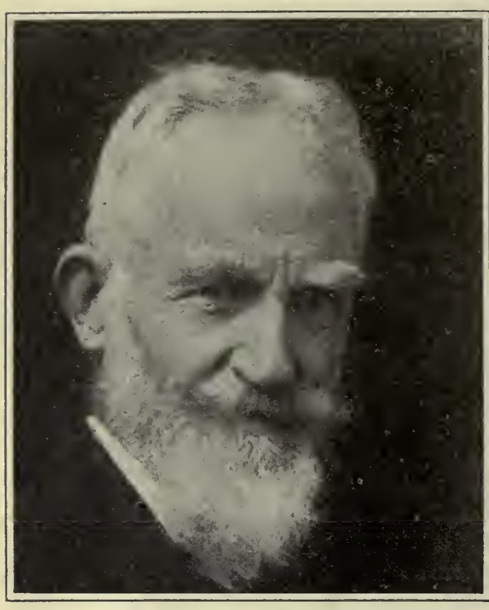
Wireless Vision Achieved

SUCH an announcement recently appeared in the London press! Strange and unbelievable as this concept of television might have seemed ten years ago, it now seems almost sure to materialize at some time not far distant. The idea of seeing what



PACHYDERM AND MICROPHONE

Station WJZ, New York, recently broadcast the sounds and scenes of the circus. "Dolly," a two-year-old elephant, is doing the right thing by the radio audience



GEORGE BERNARD SHAW
London; Author and Playwright

"If I could see and hear a play from my fireside, I would never enter a theatre again. I shall not prophesy, but I remind our managers that theatre-going is very dear, very inconvenient, and horribly stuffy and promiscuous. Unless they can overcome those disadvantages by the over-powering fascination of good plays, good acting, and theatres that are like enchanted palaces instead of hotel smoking rooms, broadcasting will knock them out."

is taking place a thousand miles away would have been classed as the working of an unbalanced mind a decade or so ago, but now, after millions of us have heard, with perfect intonation, voices of speakers thousands of miles away, why should we be surprised at seeing things from the same distance? It is, as a matter of fact, as difficult a concept to picture radio carrying on voice communication as it would be to have it carry picture messages to our eyes. In voice communication, sound has to be changed to electromagnetic waves to transmit the suitable energy impulses and then these have to be changed back to sound for the benefit of the listener. The eye requires electromagnetic waves for its activation, and this is exactly the form of energy used in radio communication.

The transmission of pictures by radio has already been accomplished and many examples of these pictures have been printed in the daily papers. By most of the present methods it takes about twenty minutes to transmit a five-by-seven-inch picture. This process is really television. If the distant scene remains fixed for some minutes, it can evidently be sent by radio to the distant onlooker. Instead of gazing into the fabled crystal sphere, however, he would look at some kind of a chart, ink marked or photographic, upon which the distant scene would be slowly reproduced.

Now, if we imagine that such pictures could be reproduced in one tenth of a second instead of twenty minutes, wireless vision would be achieved. Thus the speed must be increased some thousands of times over its present value, but this is not at all unlikely. Many of us have seen the oscillograms by which the telephone engineer analyzes his sounds and the power engineer discovers what peculiarities exist in his transmission lines. Such pictures of electric current are reasonably accurate if the wave to be photographed does not reverse more rapidly than about one thousand times a second. To get pictures of frequencies higher than this has not seemed feasible in the past, yet recently it has been found possible to photograph electric currents which are reversing as rapidly as twenty million times a second. Here is an increase of speed of about ten thousand times, accomplished by an ingenious change in the method of photography employed. Instead of using light waves to affect the photographic plate, the electrons themselves, by the activities of which ordinary light waves are set up, are used to bombard the sensitized gelatine. This revolutionary step has increased the speed of oscillography thousands of times. By a similar application of the electron's activities to the problem of radio vision, the solution does not seem improbable.

We Need More Delicacy in Radio Advertising

THE American Telephone and Telegraph Company, as has been frequently stated, is experimenting with the commercial possibilities of broadcasting. Their station, WEAF, is admittedly an advertising venture. To be sure, much excellent material is sent out over this channel which brings the owners of the station no financial return, but in the course of a week many hundreds of dollars find their way into its coffers through the appearance of the Gold Dust Twins and other organizations of a like character. The price of the station for broadcast purposes is high, but not so high, we imagine, that the annual balance does not have to be written in red

figures. Certainly its income from advertising is much greater than that of any other station. The entire radio field looks to it as a trail blazer in the realm of radio broadcasting.

In the interest, then, of radio advertising, we suggest that altogether too much time and too many words are spent in telling us who is paying for the next hour's operation of the station. A mere statement that the Happiness Candy Stores are going to give the next hour's entertainment does not harm the listeners or the candy business, but to listen to a stiff, stereotyped eulogy of this special brand of candy is irritating, to say the least. Probably the candy firm, in common with others "using the

PROFESSOR MARIUS C. A. LATOUR

The French radio inventor, whose patent claims on many important radio devices and circuits have been recognized by the American Telephone & Telegraph Company, the Radio Corporation of America, and others. The Hazeltine group of manufacturers purchased the American license for the Latour patents and the A. T. &. T. Company, and the Radio Corporation have non-exclusive licenses from Prof. Latour whose patents are such as to involve, so he claims, every radio receiver made

facilities" of this station, specifies how much propaganda must be poured into their radio channel. If this be so, we suggest that a bit more music and a correspondingly decreased period of self-approbation would be more conductive to candy buying. It takes but little propaganda to give to radio advertising a distinctly negative value and that negative value has been reached several times by the clients of WEAF.

Electrical Exports Are Increasing

THE Department of Commerce reports that during 1924, the total of our electrical exports approximates $85,000,000, a $12,000,000 increase over 1923. Most of this money is spent for machinery and transmission line equipment, but radio and its accessories are showing an ever-increasing share of the export business. The total for radio is estimated by the department to be $5,000,000. Dry batteries alone show an export value of nearly $800,000 during the past year.

South America, which last year was one of our principal foreign customers, has dropped from third to fourth place, probably due to the activity of German merchants, especially in such countries as Argentina where German sympathizers are very active.

Although the total of our electrical exports shows a very considerable figure, this pales into insignificance when our own expenditure for engineering projects is considered. Electrical power plants, dams, water and sewage systems, for 1924 mounted to the enormous total of $2,002,533,000. It's no wonder our engineering schools find great demand for their graduates when such technical activity prevails throughout the country.

Interesting Things Interestingly Said

DAVID SARNOFF (New York; vice president and general manager of the Radio Corporation of America): "In whatever direction radio may develop, it will be, I believe, toward supplementation, not substitution. The truth is, printer's ink achieves something that radio cannot achieve; conversely, the security of radio lies in the fact that it provides a different service than the printed word ever rendered or ever could render."

HUGH S. POCOCK (London; Editor of the *Wireless World*): "To-day a number of broadcasting stations in different parts of the world are making use of Esperanto as a means of linking up with other countries.

". . . The employment of short waves for long-distance transmission using low power, the importance of which was first demonstrated by the amateur worker, has provided those who conduct experimental work with a means of linking up with their fellow workers all over the world, however distant. Demonstration has, in fact, already been given that there is no point on the globe so remote that it cannot be reached on short waves by amateurs, even when using very limited power. As the range over which amateurs communicate has been gradually extended, so the necessity for some common language has arisen.

". . . To-day it is not by any means an unusual occurrence when overhearing short-wave intercommunication to come upon the exchange of comment in Esperanto between amateurs of two differ-

ent countries whilst experimental work is being carried out, each understanding the other without difficulty, although their native languages may be entirely unintelligible to either."

FRANK T. STANTON (New York; president Frank T. Stanton and Company): "I am not at all in sympathy with statements I have heard that the radio industry has been overfinanced. In fact, I still maintain that the radio industry is underfinanced. There is hardly a question that if the tremendous sums that have been paid for radio securities during the past six months had all found their way into the treasuries of the companies rather than into the pockets of the original organizers, a vastly different story could now be written regarding the market for securities representing manufacturing enterprises."

FRANK J. McENIRY (Denver, Colorado; General Electric Company, station KOA): "Never did Marconi, Armstrong, Hazeltine, Alexanderson and other famous experimenters dream that some day, the results of their efforts—radio—would be employed to capture murderers and bandits, put across community chest drives, detect human ills, recover lost dogs, and bring together parents and wandering or kidnapped children. What radio will accomplish and what is predicted for it are two entirely different things, according to experts in this field. On the face of it, however, radio is confronted with the peculiar problem of living up to everything that is expected of it."

G. C. FOSTER (New York; President of the American Piano Company): "The question as to the effect of radio on the piano business is frequently asked. We believe that radio is decidedly helpful. It is increasing the knowledge and appreciation of music, and it is awakening an interest in many to whom it has hitherto been a matter of indifference. It is increasing the desire to hear better music, especially in the home. The enjoyment that the radio brings has unquestionably pointed a way to even greater enjoyment through the actual possession of a means of making music, which leads directly to the thought of a piano."

DR. E. F. W. ALEXANDERSON (New York; Chief Consulting Engineer, Radio Corporation of America): "The shortest element of the telegraphic signal is the dot. The higher the signaling speed the shorter is the dot. Thus, while the wave amplitude is kept constant the total energy contained in the dot sign is inversely proportional to the speed of signaling. When the strongest single atmospheric impulse prevalent at any time contains as much energy as the dot in the telegraphic code it may be mistaken for a dot, or it may break up a dash into two dots, thus causing false telegraphic signals. It is therefore necessary to maintain a speed of signaling in which the total energy of the dot is somewhat greater than the maximum energy of a single atmospheric impulse. Thus, if a wave amplitude is doubled, the length of the dot may be shortened to one-half. This explains why in practice the telegraphic amplitude is double the length of the wave amplitude and also why it is inversely proportional to the atmospheric disturbance."

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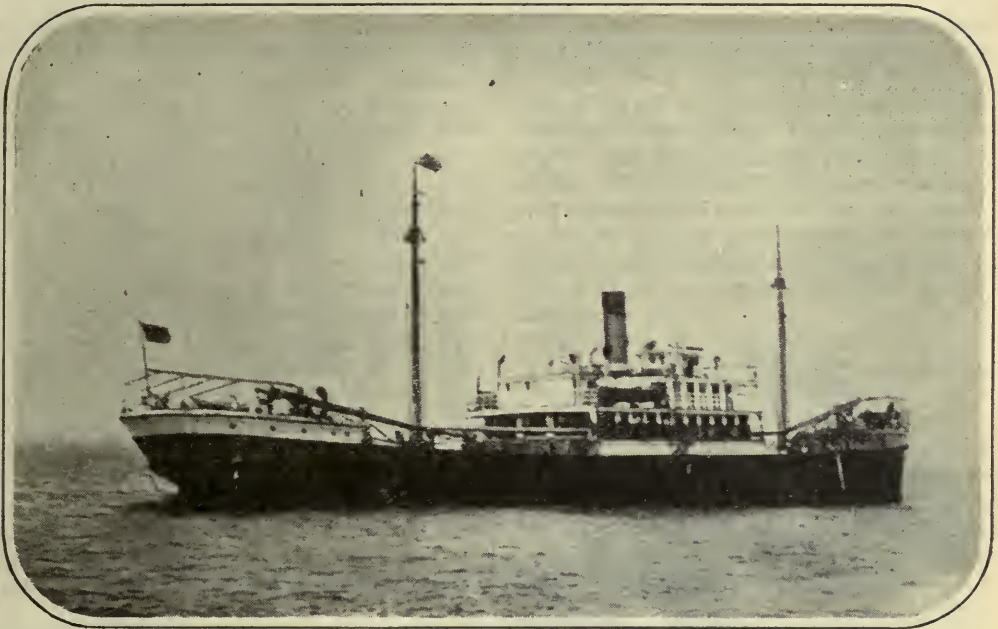
G. Y. ALLEN

New York; Radio Department, Westinghouse Electric & Manufacturing Company

"Through the use of modern developments in radio, it is entirely possible to operate electric trains from a central control office. I do not wish to be understood as advocating the elimination of the motorman, conductor, and crew. No mechanical device, however perfect, can take the place of human intelligence, but it is interesting to note some of the possibilities of radio control.

"It is now entirely feasible, through a combination of automatic control and radio supervisory control, to start a train without a crew from a station, run it at full speed over clear tracks, slow it down or stop it, in accordance with the signals of an automatic block signaling system, start it up again when the signals clear, stop it at its next station stop, and open its doors."

ALBERT E. HAASE: (New York; in an article in *Printers' Ink*): "There is no doubt in the minds of many who are getting their livelihood from radio that if this mad rush to get the advertisers' dollar for the support of radio continues, radio itself will suffer. And that would mean public resentment against advertising—all forms of advertising, for the public does not distinguish between advertising mediums. It is this point that makes it imperative for all thoughtful manufacturers to watch and study the attempts that are being made to turn radio broadcasting into an advertising medium."



THE S. S. "ARCTURUS"

The marine headquarters of William Beebe, the scientist and explorer. The *Arcturus* is the most perfectly equipped ship for scientific exploration in existence. A $3\frac{1}{2}$ kilowatt continuous wave radio transmitter aboard keeps the expedition in constant touch with the mainland. Exclusive news dispatches from Doctor Beebe appear in the New York *Times*, telling of the findings of the party

Radio's Part in the Sargasso Sea Exploration

Dr. William Beebe's Scientific Expedition to the Unfamiliar Reaches of the Atlantic Ocean is Constantly in Touch with the World by Radio

By ALFRED M. CADDELL

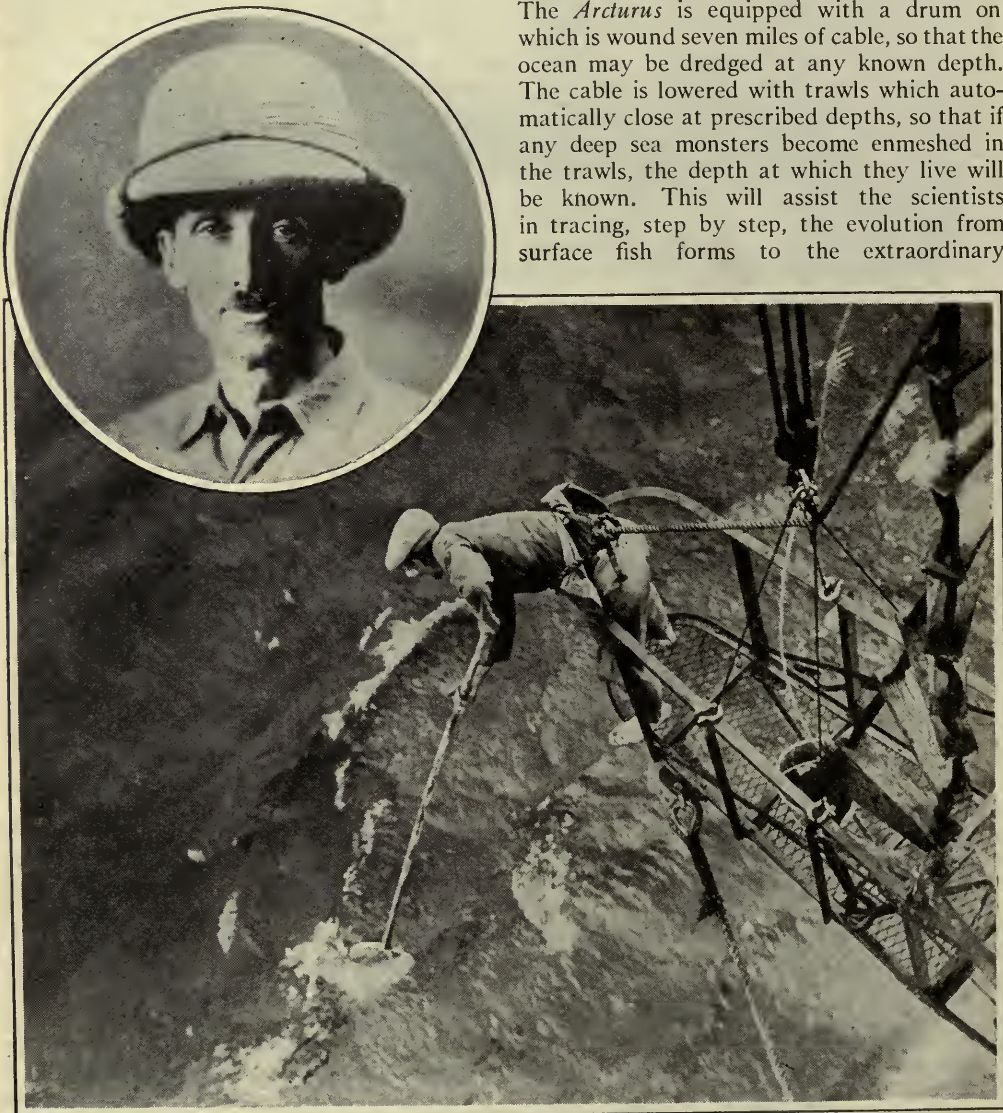
WHAT did you write on that paper that you put in a bottle and cast from the ship on your last sea voyage? Have you heard from some romantic young lady, or from some ne'er-do-well beachcomber who has found your bottled message buried in the sands of some distant resort? If not, then the possibilities are that your bottle has followed in the wake of a derelict on its way to the Sargasso Sea. Situated between two legendary points on the compass, somewhere between Africa and the Continent on the west, lies the Sargasso Sea—that mysterious part of the Atlantic Ocean which, it is thought, marks the grave of the fabled continent Atlantis, and which has now become the graveyard of derelicts floating wreckage of all sorts.

Curiously enough, human nature likes to build fables and yarns upon which to feed the imagination, and there are many weird stories told of this great waste of seaweed and driftwood. And out of these stories there has grown the belief that, perhaps, after all, there may be a Sargasso Sea. Once that is admitted it is logical to conclude that there is a sunken continent under that grayish expanse of sluggish water and that on the continent, if exploration were possible, there might be found treasures in gold and ornaments and in his-

torical value, equal to those uncovered when Tut-ankh-Amen's tomb was first opened.

And so, not so much in the hope of discovering lost treasure, but rather in the hope of obtaining valuable research data, an expedition has started for the Sargasso Sea. The expedition under the direction of Dr. William Beebe, has been fortunate in obtaining a party of noted scientists, among whom is Dr. William K. Gregory of Columbia University and the American Museum of Natural History.

The *Arcturus*, for so the vessel that has been chosen for this important work has been named, is the largest ship that has ever been employed in explorations of this character. She is 280 feet long and has a 46-foot beam. She is equipped with every facility required to probe into the mysterious Sargasso's secrets. Her laboratory, which is undoubtedly the finest afloat, is provided with every scientific instrument which can possibly be of service in making observations of whatever forms of life the dredge of the ship may bring to the surface. The *Arcturus* is equipped with a drum on which is wound seven miles of cable, so that the ocean may be dredged at any known depth. The cable is lowered with trawls which automatically close at prescribed depths, so that if any deep sea monsters become enmeshed in the trawls, the depth at which they live will be known. This will assist the scientists in tracing, step by step, the evolution from surface fish forms to the extraordinary



PLUMBING THE MARINE DEPTHS

From the bow of the *Arcturus*. A specially arranged bridge from the bow of the ship has been rigged so that the members of the party can work directly over the sea instead of having to drop a line over the side. The insert shows Doctor Beebe

marine life which inhabits the lower regions of the sea.

THE SEARCH FOR UNDERWATER TREASURES

DEEP sea monsters provide treasure for almost inexhaustible thought. Many fish with remarkable lighting systems have been caught. Some of them are said to be aflame with light, so that they look more like a Hudson river night boat than fish, while others carry green, red, yellow, and pink lights. Some have peculiar shaped lanterns at the ends of long feelers, while the bodies of others of this peculiar species of fish are studded with blazing search lights. Some have eyes from which radiance streams, and others are continuously lighted. It is believed that only a small portion of the various species of lighted fish have been caught, so that they will be subjected to very careful study on this expedition.

Another interesting phase of deep-sea life will also engage the attention of the scientists. Deep sea fish, it is known, fill their tissues with compressed gases to resist the pressure of the water at great depths, so that when they are hoisted to the surface, the diminishing pressure no longer neutralizes the pressure of gas from within, causing them, sometimes, to expand or burst like popcorn. Other fish are able to live at various levels by means of muscular valves which release the compressed gases from their tissues as they rise, and replenish their chambers again when they descend. Needless to say, special study will be given to the compressor and decompressor systems possessed by these monsters.

Then on the *Arcturus* there are many tanks and one great aquarium in which many things of interest will be brought back to New York when the explorers return from that region of the South Atlantic where the Sargasso is supposed to be.

But best of all, one of mankind's recently developed wonders is playing an important part in this expedition. We will let Charles J. Pannill, General Manager of the Independent Wireless Telegraph Company, tell us about the radio installation on board the *Arcturus*.

"If you are able to tune-in on a 2400 meter wavelength," said Mr. Pannill, "you will be able to listen-in on some mighty interesting press despatches, if you can read code. Heretofore, expeditions have seldom been heard from until they returned to their point of departure, so that when to-day we are able to follow explorers, step by step, through their

THE RADIO CABIN OF THE "ARCTURUS"

The radio equipment is controlled by the Independent Wireless Telegraph Company. The *Arcturus* is a wooden ship built by the Shipping Board during the war for the Alaskan trade. It was owned by the Union Sulphur Company and was donated by Henry D. Whiton to the New York Zoölogical Society for this voyage of exploration

tribulations and hardships, it only goes to show to what extent radio has become a daily adjunct in our lives. And, too, it is interesting to note that the progressive newspaper realizes the value of radio from the point of view of press despatches. The following excerpt from an article in the New York *Times*, takes the reader right to the spot and almost enables him to participate in the exploration:

"We are now at the site of the fabled Atlantis on Atlantic Ridge, midway between America and Africa, with 2300 fathoms of sea below us, and this morning our radio receiving set brought to us the lively music of a Pittsburgh orchestra playing 'Hands Across the Sea'—Souza's march.

"Even with continued heavy seas we have brought our heavy dredging apparatus into play, and yesterday our first bottom dredge brought up glass sponges and volcanic rock from a sea abyss three and one-half miles below us.

"The *Arcturus* has on board a radio installation furnished by the Independent Wireless Telegraph Company, and consisting of a 3½ kw. arc transmitter with daylight range of approximately 1500 miles, and also a one-half kw. spark transmitter for emergency short range work. Doctor Beebe has arranged with the New York *Times* to report an account of their operations, which dispatches are handled through the East Moriches, Long Island, station. Thus the public and the philanthropists who contributed toward this expedition are enabled to read the despatches the day after they are sent. What an advance over the communication systems of other expeditions and other days!"

The *Arcturus* left the Sargasso Sea sometime during the last week in March, and on the 29th of March, Captain J. S. Howes reported by wireless that all was well with the *Arcturus* and her crew, and gave her position as 200 miles south of Balboa, Panama, in the Pacific Ocean. The *Arcturus* had left Balboa, Canal Zone, on the 28th of March and had headed directly for the Galapagos Islands, where Doctor Beebe and his party of scientists intended to continue their researches, and also, it is believed, to study the Humboldt Current, of which little is known. But there was a period of two weeks after the *Arcturus* sailed for the Galapagos, where nothing was heard from her—nothing further at least, than the Captain's report on the 29th of March. It was then that grave fears for her safety began to be expressed, and there was much excited comment as to her fate.

The waters of the Pacific Ocean in the vicinity of the Galapagos, and following the waters of the Humboldt Current along the Peruvian coast, are far from truculent. In fact, so calm is it in this immediate vicinity that it has become noted for this alone.

Recently, Dr. Robert Cushman Murphy, Assistant Director of the American Museum of Natural History, returning from a study of the vicinity, with new data on unfamiliar currents, told of the unprecedented weather in the vicinity of the Humboldt Current, and he expressed the opinion that some trouble might have been experienced with the wireless outfit on board the *Arcturus*. But there was little ground for this belief, for as previously stated in this article, the *Arcturus* is fully equipped and ready for any possible emergency to her radio or to any other part of her scientific equipment.

Members of the New York Zoölogical Society were unable to explain the *Arcturus's* silence, for the vessel had previously communicated directly with East Moriches, Long Island, sending her position to the radio station there every day. President Henry Fairfield Osborn of the Museum of Natural History, sailed from Miami on the steamship *George Washington* recently. The *George Washington* has the same equipment as that installed on the *Arcturus*, but though the operator on this vessel attempted persistently to get into communication with the expedition, he was unsuccessful. Then it was that all vessels south of the canal zone were asked to call the *Arcturus*, and the Naval radio station at Darien, Canal Zone, was instructed to send out her call.

What then, had happened to the *Arcturus*? Had her officers and men found another Sargasso Sea, never to return and tell us about it? Or, was it merely that old complaint "static" about which we hear so much now-a-days? Perhaps, even then, they were approaching the land of the tortoise, the Galapagos, the mysterious and romantic Galapagos of the 16th century Spanish buccaneers. And, indeed, this proved to be so, for on April 11th, it was learned through the Navy Department, that once again the *Arcturus* had been heard from and that all was well with those on board.

Has Radio Any Relation to the Supernatural?

IT WAS in 1906 that Dr. Thomas Troward put forth the statement in his *Edinburgh Lectures on Mental Science* that there is no such thing as time or space: that, as the smallest portion of the ether contains all the elements of the whole, then every portion of the whole is within this smallest portion. Therefore, the entire universe is in one place and every place at one and the same time. Thus, neither time nor space exists.

This was, of course, long before the days of broadcasting, and the lectures aroused, except among those who had themselves gone deeply into the subject, the ridicule with which all new ideas are received. People thinking only on the surface interpreted Doctor Troward as saying that you did not have to cover any ground whatever to get from New York to China because there wasn't any ground. And so they went on.

VLADIMIR RASSOUCHINE
Pianist, who was heard recently at KGO and gained favor with a large number of listeners

The simple fact was that Doctor Troward was anticipating radio. Had you asked him, "What is the difference in time between London and New York?" he would have replied, "There is no difference, nor between any other two points in the world, no matter how far they are separated according to the estimate of the geographers."

We know now that this is true, and has been true since ever the earth was formed. The fact that while it may be daylight in this country it is night in China has nothing to do with the matter as set forth by Doctor Troward. He deals with those elements outside of the material that control our lives, and over which we have practically no control, and, therefore, foolishly grope our way blindly among all the other blind.

Years ago—for it must have been quite a time before these Troward lectures were brought before the public, F. Marion Crawford wrote a novel called *Mr. Isaacs,* in which the scenes are largely laid in India, and the psychic powers of the Hindoos, figure in the story. One of the characters remarks quite casually to another that he saw a mutual friend of theirs in a town some one hundred miles distant from his home although he knew perfectly well that the friend was in his home.

Marion Crawford states that long after this book was published, a woman asked him: "Why did you put such an absurd incident into a novel that, in the main, is plausible?"

Mr. Crawford replied that while he was in India he heard many such statements, and others that seemed even more impossible of belief. He asked the man who had seen his

THE EVEREADY TRIO

Whose artistic playing is frequently heard during the programs of the Eveready Hour, broadcast each Tuesday from nine to ten. From left to right they are, Alex Hackel, violinist, Edward Berge, pianist, Jacque de Pool, 'cellist

friend one hundred miles distant from where he was in the body, just what he meant. The Hindoo said, "But that is not unusual. By controlling vibrations one can project his personality through the ether to distant points."

Radio is projecting personalities in the form of photographs to distant points, by a man-made machine. Perhaps the Hindoo was right and one's personality can be projected by a God-made machine, the mind.

Impossible? Who can say that anything is impossible?

According to Edward Jewett of Detroit, who talked in an interview on what the boys have done for radio, they do not know the word "Impossible." He said:

"The boy mind grasps the theory of radio better than can the man mind because to the boy mind there are no inhibitions and impossibilities. Men, as they become men, learn that so many things, 'cannot be done.' The boy doesn't know that. So he goes ahead and does it. . . . I asked one youngster what he did when he discovered that a thing could not be done. 'Find out how to do it,' was his prompt reply."

(Perhaps by using this boy's method we may learn how to control vibrations with the mind so that we may be benefited by such control!)

To revert to Mr. Jewett:

"The youth grasps at the intangible far better than the grown person. He can see a thing that isn't there, and the minute that he sees it, then it is there. His imagination is neither tired nor spoiled. Boys think and say uncanny things. One remarked to me once, 'It's curious to know that every voice in all the world is here, now, in this very room, isn't it?'

"You mean," I countered with the old man wisdom we are so likely to effect, "that it's here if we bring it here."

"'No,' said he, 'it's here now if we will give it a fair chance to reproduce itself. If we don't hear it, that's our fault.'"

And yet you may be sure that youth had not read Troward although he was stating the basic principle of his Edinburgh lectures.

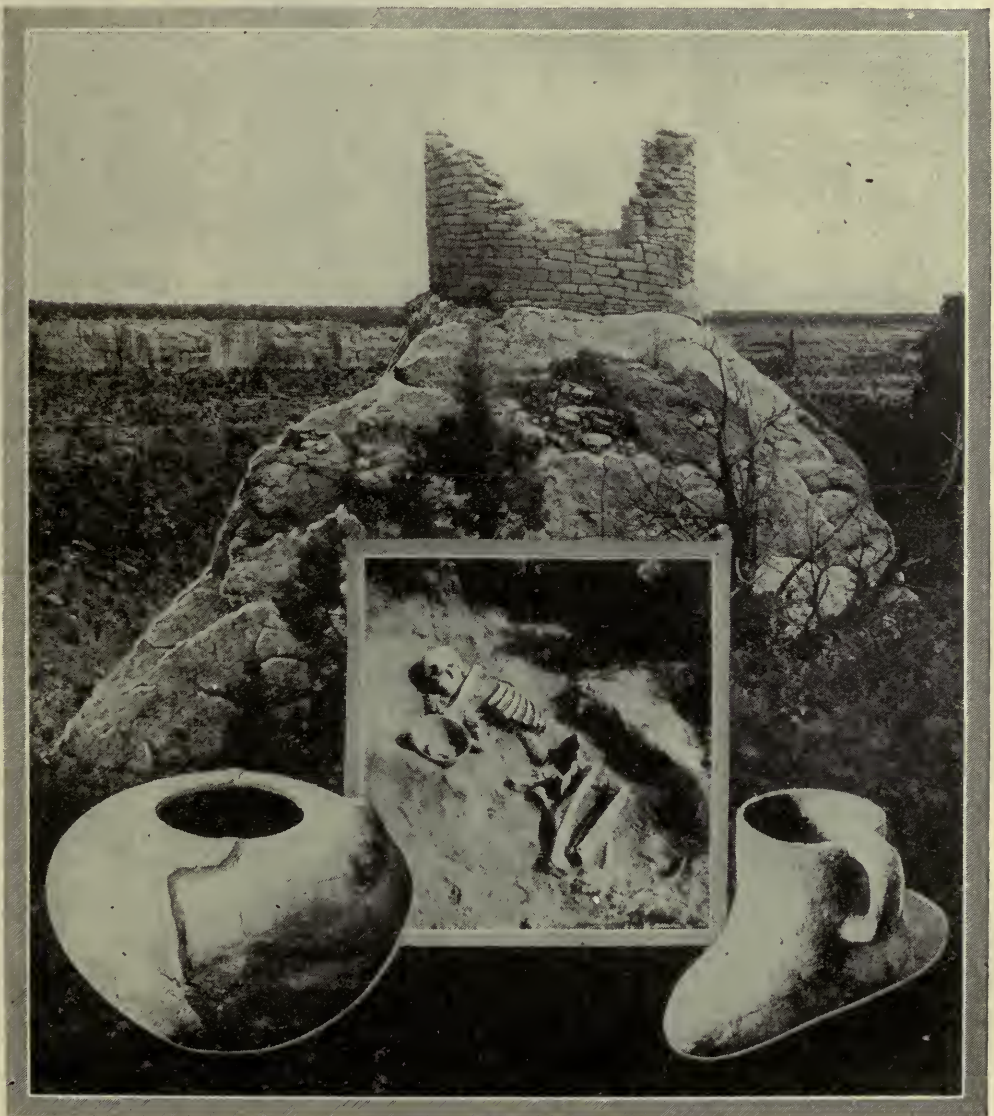
How Archæology "Came Over" on the Radio

IF YOU missed hearing Joseph Emerson Smith give a talk last month through station KOA, Denver, then you are unfortunate.

Mr. Smith was a member of the expedition sent by the Colorado State Museum to the recently discovered prehistoric city of pithouses extending along the tops of a straggling series of mesas in southwestern Colorado, and that swing from a point near the Colorado-Utah border in the Paradox Valley to Pagosa Springs, Colorado, and then south, well into New Mexico.

This is the largest lost city yet discovered on the American continent. Its civilization goes back to a period previous to that hitherto believed to be the oldest that ever existed on this continent, antedating the cliff dwellers by at least one thousand years. It is composed of scores of separate and distinct units, which, for the sake of defense advantages, were confined to the tops of mesas or tablelands, high above the valleys. Five hundred pithouses in one group alone have just been mapped in what is known as Chimney Rock.

There are tens of thousands of these pit-



AN ANCIENT WATCH TOWER

And skeleton of a prehistoric woman which were uncovered in the nearby pithouse, inhabited twenty-two centuries ago in what is now Colorado. A lecture on these archæological discoveries was given at station KOA, Denver, and is commented upon elsewhere in this department

houses, large and small, dotting the tops of the mesas. Archælogical surveys indicate that they were excavated by the original builders to a depth of from three to five feet, and were surrounded by sleeping chambers and granaries. Entrance to these homes was through a steep decline or tunnel, accommodating only one body at a time. Fires were apparently built in the exact center of the large or main room, and an opening at the roof was skillfully fashioned to let out the smoke.

So far as investigation has at present gone it has been discovered that these people had a crude knowledge of astronomy, and carried on truck gardening and irrigation. Their principal crops were gourds, tubers, corn, melons, yucca and greens. Figurines have been discovered, of rare design and finish, and pottery that might well be used for decorative purposes to-day.

The photograph reproduced on page 215 shows the remains of an old watch tower, and also the perfectly preserved skeleton of a woman about 35 or 40 years of age, who was about five feet ten inches in height. It will be seen that the right cheek was resting on the right hand, and the left arm was placed across the breast. The knees were flexed. Beside the skeleton was an unusual elaborate gray bowl decorated with a conventionalized design of butterflies. Near by was a complete pottery face, that of a doll which originally was supported by a corncob.

Mr. Smith has been quoted indirectly, because to attempt quoting him verbatim would be an injustice to the exceptional interest with which every moment of this talk was filled. Station KOA has put on many fine features during its short existence, but probably nothing of greater interest to a certain class of listeners-in than this one.

LUKE HILL

No, the small boy, who is all of seven, isn't impersonating Oliver Twist and asking for "more." As a singer he was the "hit" of the radio show given recently for the benefit of "The City of Childhood," maintained by the Loyal Order of Moose for the dependent children of their deceased brothers. It was presented through WJJD

American Music Is Inferior to None

IN THE course of a very interesting article comparing British and American radio receivers, the author says, in the *Wireless World and Radio Review* (London): "It may be said definitely that, taken as a whole, British wireless sets and components are superior to those manufactured in the United States, both in quality of workmanship, and in quality of reproduction. This is not so much due to the fact that American manufacturers are lacking in skill in the design of good transformers, etc., as it is due to the mentality of the American people. Anybody who is

intimately acquainted with modern American music, or has had the opportunity of comparing the performances of the average quality orchestras in theatres and restaurants in the two countries, will readily understand why the quality of reproduction in the British sets is so greatly superior to that in those which emanate from the U. S. A. Indeed, the performance of an orchestra which would be considered mediocre in England, is usually termed, 'Highbrow' on the other side of the water."

THE CAMERON SISTERS
Fair charmers with the flute and harp who broadcast an attractive program from KGO

Taking restaurant music by and large in England, this is no doubt true. Also, all who have taken the trouble to inform themselves regarding radio programs in that country as compared with American programs, know that England gives, on the average, music far superior to ours.

But the writer of this article, M. P. Vincer-Minter seems unconsciously, to carry the impression that *all* music produced in England, whether by radio or through the usual public channels, is superior to American music. In truth, the opposite is exactly the case. Except for her great choruses which give yearly festivals, English music as heard in concert halls and opera houses cannot for a moment stand comparison with the great attractions in these same lines available in this country every season. England has been called, "The Ballad Country," for the reason that her people have never risen, as have the American people, to a point of appreciation of the lovely and masterly songs of such composers as Schubert, Schumann, and Brahms.

Also, where this country has well nigh a dozen orchestras of the highest rank, England has one and that is the London Phil' ar' ioric. Covent Garden Opera has been discontinued since the war, while here the Metropolitan and Chicago forces are still carrying on. All these points are cited, not to correct the writer in the *Wireless World*, but because to some he may unconsciously give the impression that he is talking about American music in general.

When an Announcer Confides

MR. H. W. ARLIN, of station KDKA, who made his début as one of the world's pioneer radio announcers in 1921, assures the public that, "Although I have been continually on the job ever since then, it has never grown stale. This, for the reason that there are always certain individuals who furnish diversion. Such as, for instance, the woman who telephones: 'I have just left a package of pajamas on the street car, and would like to have the service of your station in recovering them.'"

"Or, 'I have just arrived at the Pennsylvania station and have some relatives living

in the city, but do not know where they live. Will you please announce over the radio that I am here and waiting for them to get in touch with me?'''

Or, when Christine Miller Clemson, for many years one of the leading concert contraltos of the country, was requested to sing, "Red Hot Mama!"

What the Flonzaley Quartet Think of Radio

ADOLPH BETTI, first violin and director of the Flonzaley Quartet, in speaking to the present writer of the first broadcasting experience of this organization when they were heard on a Victor program through WEAF, said:

"It is incredible, radio. It is the greatest influence in the world to-day! It will transform, perhaps, musical conditions and the transition stages may make confusion. But it will lead to glorious results. It is still impossible for me to realize that we were really heard by outside listeners as we played in that studio. We sat there, and played with the same ease and comfort as if in the parlor of friends. When the telephone calls began to come in telling how clearly we were heard even at a great distance, I could only exclaim: 'But did they really hear us?' I still cannot comprehend. I only know it is marvellous and that I am deeply interested.'"

This from one of the very greatest of living musicians.

The Battleground of Jazz Opinion

DR. R. S. MINERD raised quite a breeze among the proponents of jazz through his letter published against cheap jazz last month, judging from the letters received by the conductor of this department calling him down. He raised quite a breeze among the anti-jazzites, too. All the letters that have ever been received

"DO A GOOD TURN DAILY"

Picked members from a number of crack Scout Troops assembled around a radio set to receive instructions in hooking up and operating the one-dial Mohawk set which is to be distributed through the Chicago *Tribune* to the blind of that city. The boys are installing the sets and instructing the sightless owners how to use them

by the editor of this department upholding jazz, condemn what they call "the classics" being devoid of melody. Yet at least ninety per cent. of jazz is written from melodies drawn from the great composers, distorted for jazz purposes.

Probably, "Yes, We Have no Bananas," is not jazz, but the song is taken literally from the "Hallelujah" chorus of Handel's "Messiah."

IT IS little short of wonderful the way station KGO, operated by the General Electric Company, keeps up the high standard of its programs. Congratulations are well in order, not only for this station but KOA at Denver, operated by the same company. Both of them have fortunately managed to avoid many of the pitfalls into which new stations stumble through ignorance.

The Stage and Radio Are Not Opposed

COSMO HAMILTON, the playwright, is among those who are pessimistic regarding the effect of radio on the theatre. People simply will not go to plays. They will stay at home and listen to them by radio.

Can any one imagine an intelligent person preferring to listen-in this way to Bernard Shaw's "Saint Joan" rather than to attend the performance in person? We may be sure that the theatre will not be seriously affected by radio until sight and sound are absolutely synchronized and equally successful in production. And we doubt if even then the public will accept this sort of production as a substitute for the real thing.

WE ARE, indeed, making progress in radio music but only because a few (very few) stations have progressive program directors. In featuring a series of concerts and lectures given during February and March at the Detroit Athletic Club, station WWJ of that city made it possible for their listeners to hear, in the musical line, William Backaus, pianist of international fame, Reinald Werrenrath, and Margaret Matzenauer. One could not ask for more than this.

ANY day or evening you can tune-in and hear from one station or another some of the latest books discussed. It may interest the broadcast directors to know that many people enjoy this feature who are not among those inclined to write letters expressing their commendation.

FLORENCE STERN
The youthful violinist who has been heard through station WEAF

THE young woman who, each evening at 7.05, from station WBZ, Springfield, talks to the kiddies is one of the star radio entertainers along this line. She gives the children such worthwhile stories that they are also enjoyed by grown-ups, which is the test that all stories for children must meet before they can be called literature.

MISTAKES in program printing are not infrequent. A short time ago a program contained the announcement, "Valet Music from Rosamund Suite by Schubert."

THERE must be good piano teachers in Iowa and Nebraska judging from some of the pupils heard through the radio stations in those states.

ALL communications addressed to this department should be signed with the full name and the address of the writer. Letters are sometimes received that contain valuable comments or suggestions, but signed with a fictitious name. It is contrary to the policy of this department either to quote from or otherwise to acknowledge any anonymous communication.

How to Make a Chemical Plate Supply Unit

A Double-Wave Rectifier Without Any of the Faults of the Usual Type—It Is Very Simple and Inexpensive to Make and the Parts Can Easily Be Secured

By JAMES MILLEN

THIS article of Mr. Millen's is a careful presentation of a new suggestion for a chemical rectifier to furnish plate potential. The average person is inclined to think that a chemical rectifier is necessarily sloppy and unreliable. This is not precisely true. A well-made chemical rectifier is, all things taken into consideration, highly satisfactory for use as a plate supply. This unit will furnish plate potential up to 120 volts and current enough for any receiver. On tests made on one of these units connected to a receiver in our laboratory it was noted that no hum at all was present in the loud speaker or telephones. It will be seen that the whole unit can be put together for less than $20, and for those who are anxious to build a plate supply unit, we can recommend this highly. Service tests of several hundred hours' duration made simultaneously with three complete units failed to show any noticeable sign of deterioration in any of the units. The Bureau of Standards Technologic paper No. 265, "Theory and Performance of Rectifiers" by H. D. Holler and J. P. Schrodt may be found very interesting to those readers who wish to go deeper into the theoretical side of this subject than Mr. Millen has.—THE EDITOR

THERE have been many articles published on B eliminators employing thermionic tubes, mean free path gas tubes, and even miniature dynamotors and motor generators. Very little has as yet appeared about a system which is in many ways superior to any of the others. No doubt this evasion of the chemical rectifier is due to a considerable extent to the existing opinion in the minds of many that this type of rectifier is sloppy, inefficient, and requires considerable attention. This, unfortunately, is true of the majority of borax rectifiers used in many amateur transmitting stations. Several years ago when chemical rectifiers were first used for that purpose someone suggested a solution of borax as an electrolyte and as a result borax has been almost exclusively used for this purpose ever since. Of all the different solutions available, borax is in my opinion by far the poorest. In fact one is almost justified in condemning the chemical rectifier if his experience has been restricted to the use of borax as an electrolyte.

Fortunately, however, there are several exceedingly fine solutions for use in lead-aluminum rectifiers, and a properly made cell, such as is described in this paper, is compact, clean, inexpensive, and efficient. Furthermore, it will seldom require any attention. The reliability of the chemical rectifier when properly made is most strongly emphasized by its use by one of the largest public utility corporations in the world.

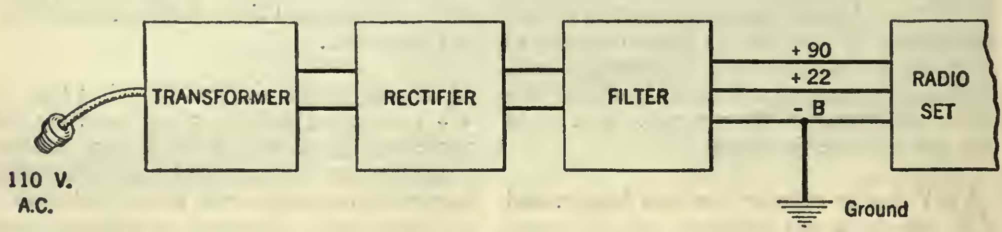


FIG. 1

From lamp socket to radio receiver. The illustration shows the entire system as used to change the 110 volt alternating current to a variable d. c. voltage for supplying plate potential to any radio set

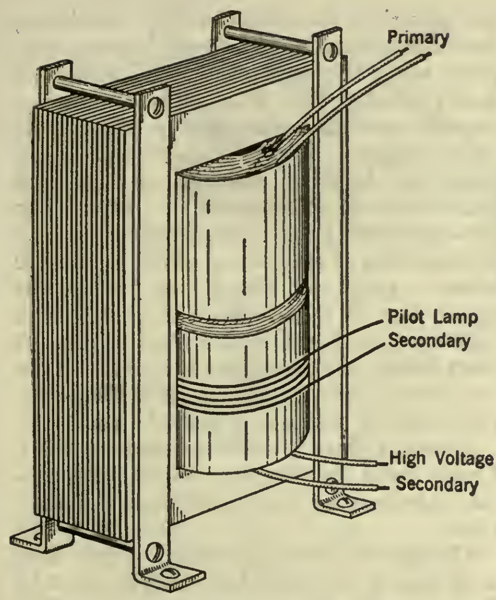


FIG. 3

A sketch of the transformer which steps up the voltage to compensate for the drop in voltage through the rectifier. This transformer is easily reconstructed from a toy transformer. An additional winding of a few turns provides for the pilot light current supply

As the chemical rectifier unit is very much cheaper than a tube rectifier, it is possible, without greatly increasing the cost of the complete B supply unit, to rectify both halves of the alternating current cycle. This complete rectification makes possible the use of a much smaller filter system. Still another reason for the much greater ease with which the output of a chemical rectifier may be filtered is the high inherent electrostatic capacity of the unit. The capacity of the single unit described in this paper is approximately 1 mfd. as compared with the negligible capacity of thermionic tubes.

Each cell (when used with the solution mentioned below) will stand well over 100 volts, which makes it possible to obtain between 80 and 120 volts at the set, depending upon the transformer voltage. This is ample when used with the average broadcast receiver. Where it is necessary to rectify higher voltages, then several cells must be used in series.

CONNECTIONS OF CHEMICAL RECTIFIERS

THERE are two methods of connecting chemical rectifiers. In the first or bridge method, Fig. 4, four small cells are required. In the second method, Fig. 8, only one cell (slightly larger) is required, but a double transformer secondary is needed to feed it. Thus the saving in rectifier cells in the one case is more than offset by the additional transformer secondary required in the other.

The jar is a three ounce "salt mouth" bottle fitted with a rubber stopper having three holes, as shown in Fig. 2. The electrodes are $\frac{5}{16}$-inch rods. The aluminum rods must be chemically pure. Commercial aluminum will positively prove unsatisfactory. Lead rods, chemically pure aluminum rods, and "salt mouth" bottles are carried by the large chemical supply houses. Eimer and Amend, 18th St. and 2nd Ave., New York City can furnish these supplies. In drilling, tapping, and cutting the aluminum, extreme care should be exercised not to lay the rod in any metal filings which may be on the work bench, or to fasten it in the metal jaws of a vise unless protected by wood, cloth, or paper. If any small metallic filings become imbedded in the surface of the aluminum, then the film of aluminum oxide which forms and breaks down again with every reversal of the current when the rectifier is in operation, will not be complete at that point. In operation, this failure

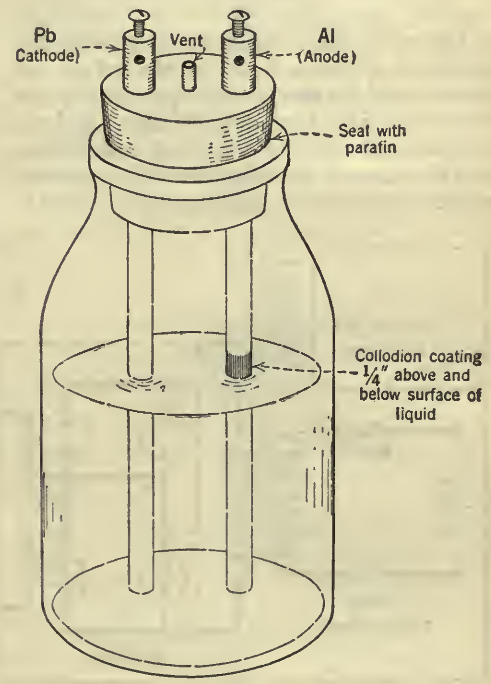


FIG. 2

The rectifying jar. Several of these cells go to make up the complete rectifying unit. The anode, cathode, and vent are supported in a cork top

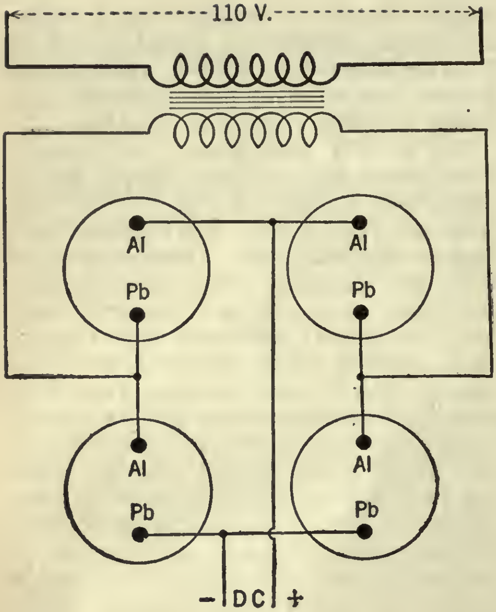


FIG. 4

The circuit of the chemical rectifier. Four jars are arranged in series-parallel to obtain the double-wave rectification which is properly smoothed out in the filter resulting in a direct current

of the oxide film completely to insulate the aluminum electrode from the electrolyte will be indicated by tiny sparks appearing at the impurity. This type of sparking should not be confused with the general scintillating sparking caused by using too high a voltage across the rectifiers. Such sparking is due to the electrical breakdown of the insulating film of aluminum oxide and will begin to take place when the impressed a. c. voltage is over 160 volts. The aluminum electrode in a properly operating cell will glow with a pale yellowish-green light and there will be no sparking. A slight sparking does not, of course, make a cell inoperative. In order to prevent sparking and consequent consumption of aluminum at the surface of the electrolyte where a protective film is not formed, the upper part of the electrode is coated with collodion, as shown in the illustrations. A short length of glass tubing is inserted in the vent hole in order to prevent its closing when the stopper is squeezed into the bottle.

Although there are several good solutions, I have found the two given below to be considerably superior to any others that I have tried.

Though not very generally known, they were among the original electrolytes used by Professor Nodon in developing his "Nodon" Valve. (See list of references at the end of this article.)

WHAT SOLUTION TO USE

THOUGH not the better of the two, the solution most easily obtainable is a saturated solution of ammonium borate. It is most easily prepared by the layman by adding several tablespoonfuls of ordinary boracic (or boric) acid, such as is to be found in the medicine chest of every home, to a half quart of distilled water in a glass or china container. Add four tablespoonfuls of ordinary household

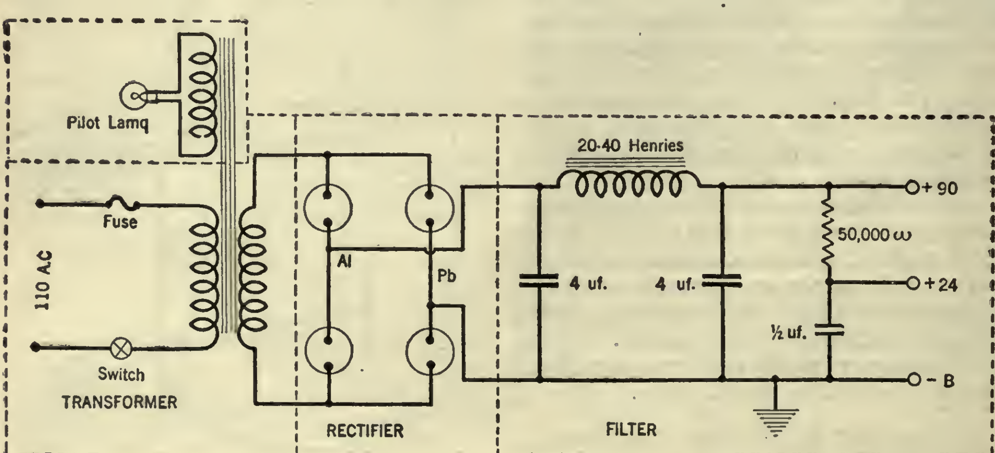


FIG. 5

The complete circuit diagram of the chemical plate supply from input to output. The dotted lines indicate the various subdivisions of the device, as follows: pilot filament, step-up transformer, chemical rectifier, filter. Usual engineering practise is used in this diagram referring to condenser capacities

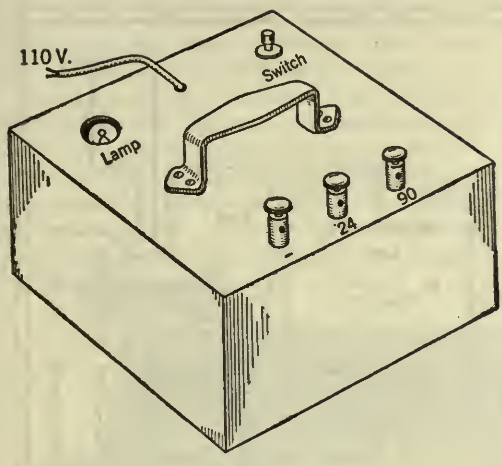


FIG. 7
The three posts on the right are the output. An external resistance (variable) is connected between the +90 and +45 posts to obtain the detector voltage

ammonia (the clear kind—not the kind containing soap or borax). Shake well and let stand for several hours. The excess salt will precipitate on the bottom and the clear solution is to be used in the rectifiers.

The other, and better, electrolyte is a saturated solution of primary ammonium phosphate. ($NH_4H_2PO_4$). It is prepared by adding enough crystals of primary ammonium phosphate to one-half quart of distilled water so that no more will dissolve and then using the clear solution after the excess crystals have settled to the bottom.

The practice of adding sodium or potassium salts to the electrolyte in order to reduce its resistivity is not to be recommended, for it will pit and corrode the anode (Al). The presence of sodium salts in any quantity will also cause the rectifier to give off an unpleasant odor after it has been in use for some time.

Never add anything but distilled water to take care of the loss of electrolyte due to electrolysis and evaporation. Addition of distilled water for every 400 hours of use will generally be sufficient unless an unusually large vent is incorporated in the cell.

In order to prevent a short circuit when the negative B terminal of the set is grounded, which is generally essential in order to entirely eliminate all a. c. hum, and also to raise the a. c. voltage, it is necessary to provide a transformer in the 110 volt a. c. line. The standard 75 watt amateur c. w. type transformer may be used for this purpose by running it with a resistance in the primary circuit or by feeding the 110 volt winding with a lower voltage obtained from a toy step-down transformer, in order to reduce the out-put voltage to a usable value. Such an arrangement is, however, both needlessly expensive and inefficient. A bell-ringing transformer may be worked backwards from a toy step-down transformer. Another bell transformer can not, however, be substituted for the toy transformer. Very satisfactory results were obtained by using an Acme 1½-henry double choke as a transformer. One winding serves as a primary and the other as a secondary. The air-gap must be tightly closed. (Some choke coils have no air-gap.) This will, of course, be merely a "one-to-one" transformer, and due to the design, the voltage regulation is poor.

HOW TO MAKE THE TRANSFORMER

FOR best results, a transformer should be made which will meet the exact requirements. As the cutting and rolling of silicon steel for transformer cores is a task which the average person will not care to tackle, the use of the core from a toy step-down transformer is recommended. These cores are well made, of the shell type, and of the right size. The only thing to be discarded is the low voltage secondary. Moreover, they may be purchased at very reasonable prices, the list for the one best suited for this purpose being but $3.75. A transformer should be selected which has a no-load power consumption of not more than ten watts. The transformer referred to above and used in the current tap shown in the photographs meets all these requirements. It is the new model 40 watt

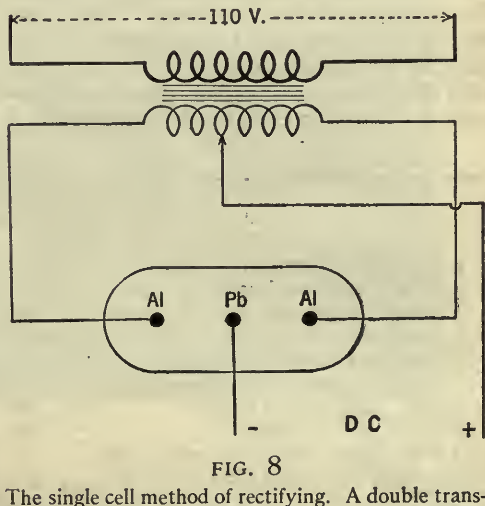


FIG. 8
The single cell method of rectifying. A double transformer secondary is necessary as the circuit shows

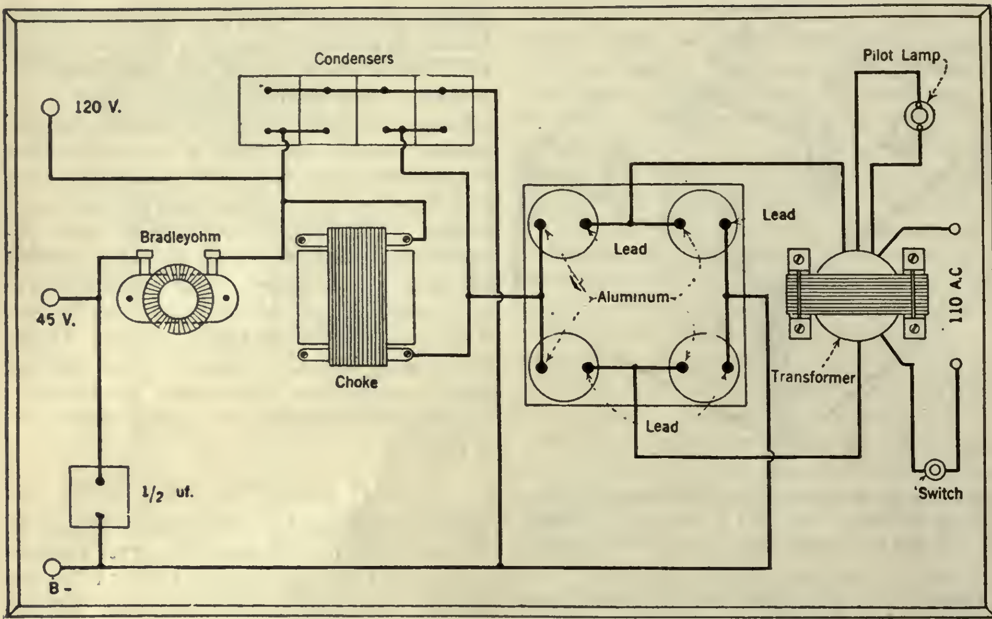


FIG. 6

The wiring layout. This drawing should be compared with the circuit diagram in Fig. 5 to identify the several parts and also the internal circuits of the choke coil and the transformer. The voltage regulation will be from 120 to 90 and 45 to 24, depending upon the internal characteristics of the transformer

Lionel toy transformer. The task of removing the core will be greatly simplified if some alcohol is first applied in order to dissolve the shellac which binds the core together. Remove the low voltage winding and in its place substitute a secondary wound with No. 28 or No. 30 enameled copper wire. Insulate each layer with thin tough paper. Protect the new winding from the core and case with Empire cloth or other suitable insulation. The proper number of turns will be 1125 for use with ammonium borate electrolyte and 1030 for use with the primary ammonium phosphate electrolyte. In either case, the final filtered d. c. voltage will be approximately 110 volts. For lower voltages use fewer turns.

The fact that turning off the A battery switch on the set does not shut off the input to the power unit, makes it desirable to employ a pilot lamp in order to remind one of the second switch. This lamp should be so connected as to burn whenever the power unit is turned on. A small-flash light bulb, or even an automobile type bulb may be used for this purpose. In order that its life may be long, it should be burned at less than rated voltage. It is to be fed from a separate transformer winding of a few turns of No. 20, No. 22, or

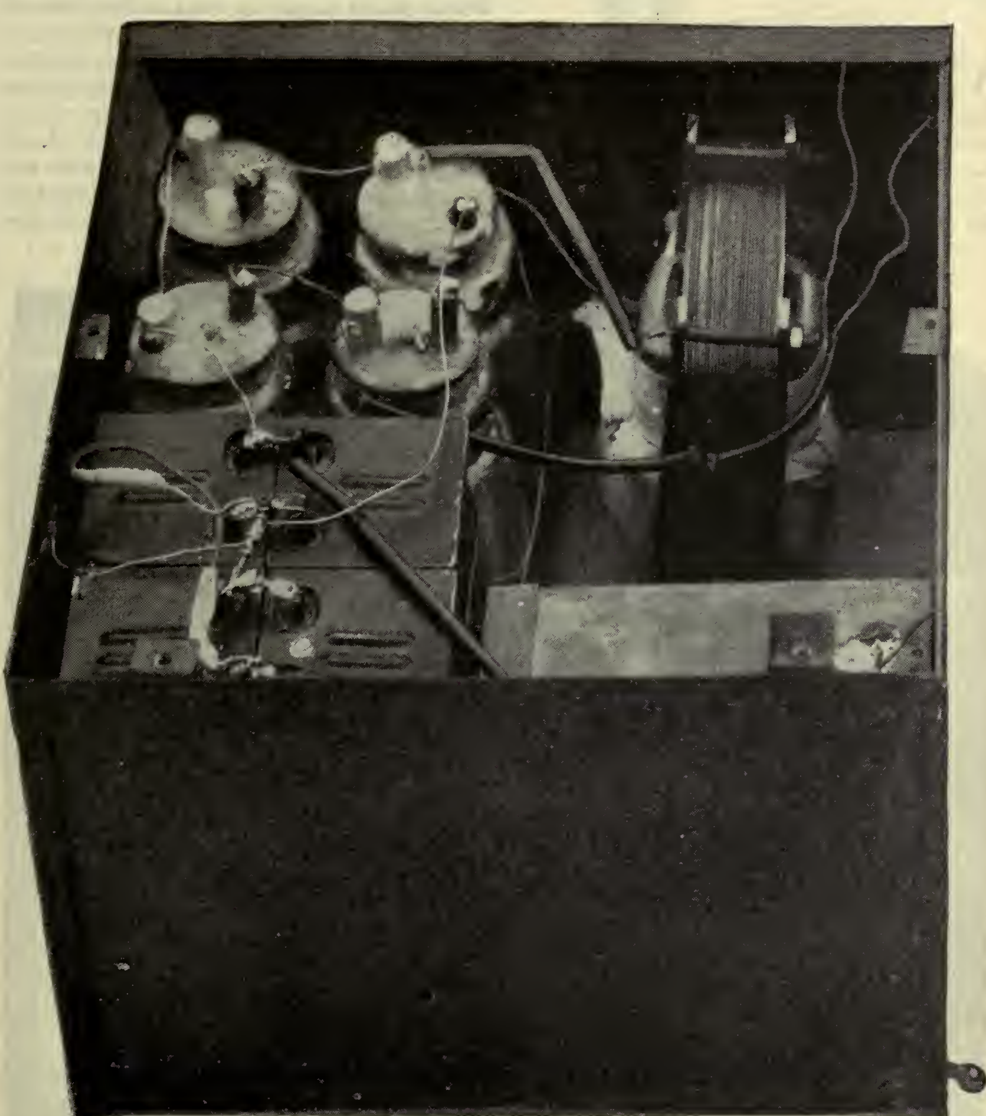
PARTS REQUIRED

2 Lionel transformers, 40 watts	\$7.50
4 W. E. 2 mfd. condensers	3.60
1 pound No. 30 enameled copper wire	.88
1 Bradleyohm No. 10	2.00
1 Flashlight bulb and socket	.20
Steel box, panel, binding posts, etc.	
4 3-oz. "salt-mouth" bottles	.20
4 No. 6 rubber stoppers	.20
1 2-ft. length chemically pure aluminum rod $\frac{5}{16}$ inch diam.	.20
1 2-ft. length lead rod $\frac{5}{16}$-inch diam.	.20
1 6-inch length $\frac{3}{32}''$ outside diameter glass tubing	.05
1 oz. $NH_4H_2PO_4$ at 60c 8 oz.	.15
Total between \$15.00 and \$16.00	

The lead and aluminum rods come in 2-foot lengths. This is more than required, but fractional parts of a bar are not sold.

No. 24 wire. The winding must be well insulated from the other windings. Ten turns will be right for a 3-volt flashlight bulb.

If the output of the rectifier were to be fed directly into the radio set, a disagreeable hum would be heard in the loud speaker. The first step to be taken in the elimination of this hum is to pass the current through a filter before it reaches the set. The purpose of the filter is to "smooth out" the pulsations in the rectified current in much the same manner as the air dome on a reciprocating water pump "smooths out" the flow of the water. Where very large capacity condensers are employed in the filter circuit (such as described by Mr. C. J. Lebel in the September, 1924, RADIO BROADCAST) then a more nearly correct hydraulic analog would be a pump feeding a reservoir from which a steady stream of water might be drawn. Filters of the reservoir type, while exceedingly effective, are needlessly expensive and cumbersome, so that the use of a filter of



RADIO BROADCAST Photograph

FIG. 9

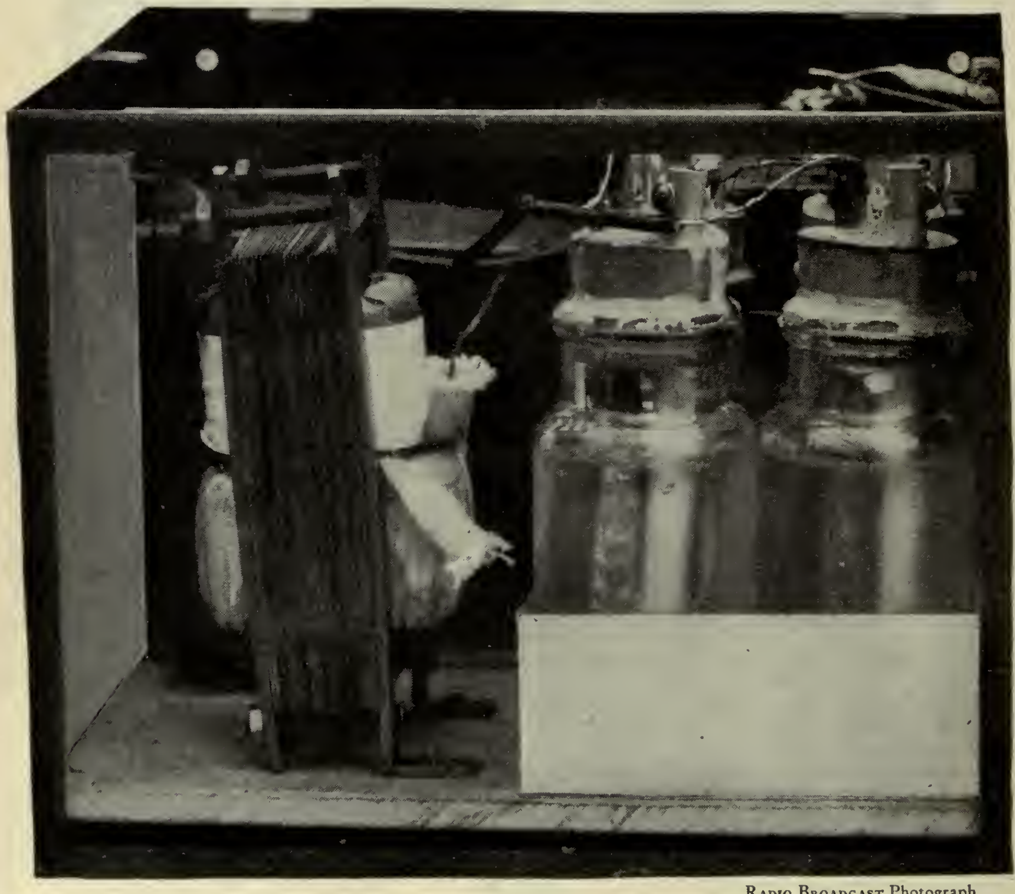
The top is removed from the unit to show the construction. Either the transformer or choke coil should be shielded. In this model, the choke coil is shielded. This shield is grounded to the metal box which in turn is connected to the negative side of the output supply

the "smoothing" type, such as was described in RADIO BROADCAST for December, 1924, by Mr. R. F. Beers, is to be recommended for use with this B supply unit. (When an S tube is employed as the rectifying device, then it becomes imperative to use the larger filter). The filter details are given in Fig. 5. The choke coil should have an inductance of about twenty henries and must be of fairly low resistance. The choke referred to in the December, 1924, RADIO BROADCAST meets these requirements.

MAKING THE CHOKE COIL

AN EXCEEDINGLY fine choke for use with this outfit consists of one pound of No. 30 enameled copper wire wound on the same type of core as recommended for the transformer. If No. 30 wire is used for the transformer secondary, then one pound of wire will be sufficient for both purposes, as the transformer will require only about an ounce of wire. The d. c. resistance of such a choke is but 320 ohms. Thus the voltage drop across the choke will be negligible. The use of audio frequency transformer secondaries as chokes is not to be recommended, because of their extremely high d. c. resistance. (About 2500 ohms for the average transformer secondary.)

There have been many complaints about B substitutes whose output voltage varies considerably with different loads. Thus such devices might supply 90 volts to the plates of the amplifiers in a small two- or three-tube set equipped with proper C batteries, whereas they would not deliver more than forty or fifty volts when connected to a big "super," especially if no C batteries are employed. Such difficulties will never be encountered with the current-tap described in this paper, owing to the extremely low relative resistance of the



RADIO BROADCAST Photograph

FIG. 10

A metal pan for the jars keeps them in place and prevents spilling of the electrolyte and the breaking of jars. A wooden sub-base allows the unit to be assembled first and then placed in the metal cabinet

choke and valves as well as the excellent voltage regulation of the shell-core transformer employed.

DETAILS OF CONSTRUCTION

THE next and almost equally important step to be taken in the hum elimination is the grounding of the negative B lead from the B eliminator. This is very important! *Before doing it, however, examine the regular ground connection to your set and see whether or not it is on the opposite side of the A battery from the negative B.* If it is, then a large fixed condenser must be connected in series with the regular ground lead or else it must be removed altogether. (We mean the ground to the set, not the ground to the power supply.) If both sides of the A battery were to be directly grounded, the A battery would be short circuited.

The third step is to insert C batteries in your set so as to reduce the tube space current to a minimum consistent with good quality.

The fourth step is to shield the choke coil from the power transformer. If they are both in the same metal box, then merely placing their cores at right angles to each other may be all that will be required, although quite frequently it is necessary to place a grounded iron or steel partition between them, or even to place one of them in a separate metal box. The entire unit should be located at least three feet from the set. This is not always essential, especially where the unit is thoroughly shielded, but nevertheless it is a good rule to follow.

The fifth and last of the precautions to be taken is to remove as far as practicable from the set any lamp cords carrying house current. Occasionally when one fails completely to eliminate all the a. c. hum in a receiver using this B supply it may be due to ungrounded BX cables and conduits which are used in the house wiring.

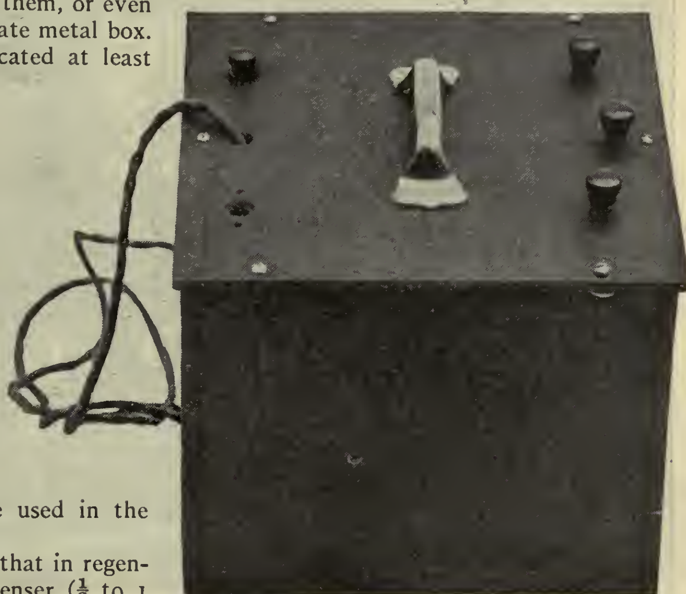
It might also be well to add that in regenerative sets a large fixed condenser ($\frac{1}{2}$ to 1 mfd.) must be connected directly from the plus detector B binding post on the set to the negative B binding post. This condenser must be located at the set and not several feet away at the unit itself. The small condenser connected across the primary of the first audio transformer in many such sets will not act as a substitute for the larger condenser connected as explained above. All regular neutrodynes have a small condenser connected directly from the detector plate to the negative B which is sufficient in such cases. Don't, however, try such an arrangement on a regenerative set or it will cease regenerating.

The small pocket voltmeters sold for testing B batteries are worthless for determining the

FIG. 12

A dummy jar element unit showing how Fahnestock clip binding posts of a special type can be used to connect to the elements. The support stopper is of rubber. The clips are so designed that they will slip easily over the anode and cathode tops

RADIO BROADCAST Photograph



RADIO BROADCAST Photograph

FIG. 11

The finished product. It is neat in appearance and very convenient. The unit may be placed on a lower compartment of the same table as the radio receiver, unlike many unsightly home made plate current supply devices

voltage supplied to the set by a B substitute. If a milliammeter and some B batteries are available, then a fair method is to read the plate current when the power supply is being used, and then switch over to the B batteries and by varying the number in use, obtain the same plate current as with the power supply. The voltage of the B substitute is then roughly that of the B batteries, producing the same plate current.

The cost of operating a power unit drawing approximately ten watts from the house current is $0.0009 per hour, Thus it costs but about ninety cents for one thousand hours of B supply and there is no shelf life deterioration when the set is not in use.

GENERAL REFERENCES

For the benefit of those who may desire to obtain further information on the interesting subject of electrolytic rectifiers, the following references are given:

Vol. 1: *Transactions of the International Electric Congress of 1904* "The Nodon Valve," by Prof. Nodon.

Vol. 1: *Transactions of The American Electro-chemical Society, 1902:* "Electrolytic Rectifiers," by Prof. Burgess.

QST: June, 1922, "Electrolytic Rectifiers for Amateur Transmitting Work," by S. Kruse.

These references are mainly of a scientific nature and contain little constructional information which would help the builder of a plate supply unit such as described in this paper.

WILLIAM H. ECCLES

Demonstrating at a lecture at the Imperial College of Science in London a circuit on which he has spent much time, which is to bring about a new method of wireless communication. The sending apparatus produces easily recognizable musical chords at the receiving station. The most common chords would be assigned to the vowel sounds. Dr. Eccles is Professor of Applied Physics and Electrical Engineering at the London Technical College and a well-known authority on radio

as the broadcaster sees it

by **Carl Dreher**

Drawings by Franklyn F. Stratford

Computing How Far a Radio Station Can Be Heard

MR. HARRY L. BEACH of Bristol, Connecticut, referring to our article on the SOS in RADIO BROADCAST for March, raises a pertinent issue. He writes as follows:

While listening to the various stations each night, if I get KGO I am highly elated, having accomplished an extraordinary feat. On the other hand, if I get some little station in New Jersey, I never know whether to be elated or scornful. You have proposed an empirical formula for the interference caused by any station to a 600-meter signal. Can you produce an equally simple formula expressing some convenient unit of power or relative power available to me from a broadcast station, given its distance watts and frequency? Local conditions and the efficiency of my receiver make it impossible for me to compare directly with any other receiver, but if I knew I was doing as well to receive XYZ at 200 miles as KGO across the continent I would have that "Grand and Glorious Feeling" more often and would worry less.

A formula along these lines already exists, fourteen years old. It is the Austin-Cohen transmission formula, first reported in "Some Quantitative Experiments in Long Distance Radio Telegraphy," by L. W. Austin, in the *Bulletin of the Bureau of Standards*, Vol. 7, No. 3, Page 315, and reprinted in numerous places since. This formula gives the received current in terms of the current in the transmitting antenna, the effective or electrical height (which is only a fraction of the physical height) of both antennas, the wavelength, the distance, and some exponential factors. The exponential factors may be neglected—not because they are small, for as a matter of fact they are exceedingly great, but for the reason that distance reception is accomplished at those times when the absorption is slight, and the loss in signal is only that imposed by the simple inverse-with-distance law. In other words, the only time that a listener has a chance to make a distance record is when atmospheric conditions are such that the exponential factor approaches unity and does not figure in the problem.

It follows that the ability of a station to reach out is expressed by its meter-amperes product, obtained by multiplying the effective height of its antenna by the amperes flowing in the ground lead thereof. Suppose we have a typical 500-watt station with an antenna whose physical height above ground is 150 feet (roughly 50 meters). The effective or electrical height might be half of that, or 25 meters. The antenna current will be around 8 amperes. Hence the meter-amperes product is around 200. Some "mosquito" broadcaster might have an ampere in the antenna and a height of ten meters electrically: he would rate only 10 in this scale. High power trans- and inter-continental radio telegraph stations range from 20,000 to 300,000 meter-amperes.

The sporting factor sought by Mr. Beach might be very simply expressed as

$$\text{DX Index} = \frac{\text{Distance in Kilometers}}{\text{Meter-Amperes}}$$

The only trouble is that the Department of Commerce does not publish the meter-amperes product of broadcasting stations, although it asks for them in the license application. Worse, this product is seldom accurately known, because a rather intricate procedure is required to determine the electrical height. So, for practical purposes, we are more or less out of luck. A rough approximation would be simply to divide the distance in miles by the power in watts. The Department does print the ostensible power of the stations in occasional issues of the *Radio Service Bulletin*, a monthly publication obtainable from the Superintendent of Documents at twenty-five cents a year. On this basis, KGO with, say, 2,000 watts in the antenna, heard over a distance of 3,000 miles, would have a constant of 1.5. KMO, with 10 watts, would have the same constant only 15 miles away. This looks as if there should be some weighting in favor of the higher powers, cutting them down a little. However, with the meter-amperes product unavailable the problem really passes out of the realm of engineering speculation. It reminds me of a remark of Professor N. S. Shaler regarding the scientific value of spiritualistic manifestations, that it is like trying to make a topographic survey of the land of dreams. Besides, we have steered entirely clear of such factors as frequency.

Nevertheless, the fact remains that our correspondent's idea is a logical one. The fault is in the rating of stations by power alone, neglecting consideration of the actual radiating element, the antenna. If DX fishing is anything at all, it should follow that the smaller the fish, other things being equal, the greater the glory. It is therefore a unique sort of fishing, for all the followers of Izaak Walton boast of the great size of their catches; they love to stretch wide their arms and mouths when recounting their piscatorial exploits. The advent of real super-power stations will put a crimp in DX motives. But as long as little stations exist, they will have the function, not only of affording expression to local talent and taste, but also of keeping the DX spirit alive, by giving its devotees an almost inaudible signal, smothered in noise nine tenths of the time, to shoot at.

Signor De Luca Tips the "Mike"

OUR illustration shows what happens when you let the artists run a station, or rather what would happen if they were allowed to run one. Here is Signor Giuseppe de Luca, one of the most talented of baritones, publicly tipping a carbon microphone. Naughty, naughty! For, when a carbon transmitter is tipped at such an angle, it ceases to be a microphone. The carbon falls away from the diaphragm, and can no longer transform into electrical impulses the agitations produced in the latter by sound waves. Microphones of this type must be kept in the vertical plane if one intends to allow it to be acted upon by voice or music. But in a photograph any microphone one can find, is just as good lying down as standing up.

THE TIPPED MICROPHONE

Giuseppe de Luca, baritone of the Metroplitan Opera Company, toying with a broadcasting microphone. When the microphone is placed in this position, it becomes practically inoperative

Looking at the picture again, we derive an obscure but definite, anarchistic pleasure from it. We are so tired of upright microphones! They stand for good transmission or the devil to pay, for correct placing, proper vocal-orchestral balance, criticism, watchfulness—all the tribulations and strains of the job of broadcasting. But a slanting microphone—there is freedom, a simian carelessness for consequences, a flinging of heels to the sky! It affects us like the spectacle of an orthodox, stout, and reputable citizen, reeling, in evening dress and hopelessly drunk, down Fifth Avenue on Sunday morning while the church-bells ring for all those who can hear them. Bravo for Signor de Luca and the publicity representatives!

The "Layer of Lines" Confesses

IN THE New York *Herald-Tribune* for February 27th, "Pioneer," one of the bright constellations of radio criticism, writes:

> The lines from Schenectady to New York were blown down by high winds last night. That is why the comedy by the WGY players did not come as scheduled to the listeners at WJY. We wonder if this was not due in some measure to careless laying of the lines.

"Pioneer" is a charming, conscientious, but non-technical lady; she has never straddled a cross-arm forty feet above ground in a howling gale; the pole covered with ice, perhaps, and maybe a 30,000 volt transmission line in close proximity. In other words, she has never had the job of keeping an open wire circuit during bad weather.

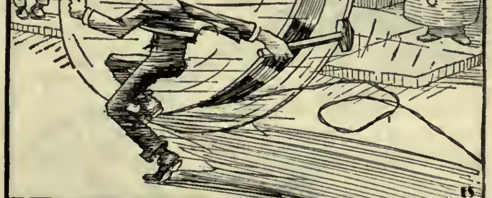
It happens that I am very intimately connected with WJY, in fact, I "lay" the lines. Whenever WGY and WJY are hooked up, I start out from Aeolian Hall in the afternoon, a reel of twisted pair twelve feet in diameter under my left arm, my mouth filled with carpet tacks, and a sledge hammer in my right fin. Loping along at the pace of Mr. Nurmi, I pay out the line with inconceivable rapidity, dodging trains, automobiles, and dangerous animals, and here and there fastening the pair to a handy telegraph pole with a carpet tack and a blow of the hammer. I cross creeks, rivers, ridges, valleys, and mountains, keeping as straight a course as possible up the Hudson Valley. At about the same time a representative of WGY starts south with the same paraphernalia and good intentions. We meet at Poughkeepsie, splice the wires, drink each other's health in a bucket of Hudson River water, and return to our respective stations.

On the afternoon of February 26th, observing the nasty weather, I fortified myself with three or four dozen drinks, prescribed by my physician, before starting out on my course. Something was wrong with those drinks, or else I did not have enough, for no sooner had I started than I perceived that I was not in my best form. I veered from one side to the other of Manhattan Island, missed the telegraph pole at Columbus Circle, striking a traffic officer instead, and mashed my thumb instead of the carpet tacks in several instances. Nevertheless, after the fashion of heroic radio men, I persisted and made fair progress until the Harlem River was reached. I generally cross this by way of the Spuyten Duyvil bridge, because a pretty girl lives near the Bronx end of the viaduct and waves to me as I pass. Besides the girl, I always pay the tribute of a thought to the intrepid Dutch courier who perished here when he plunged into the flood, crying that he would cross "in spite of the Devil!" to warn the burghers of New Amsterdam of an Indian rising to the north—from which episode the strait derived its name. All I can say is that I headed directly for the bridge. I missed it by fifteen yards, equivalent to about a foot for each drink. *Maladetto diavalo,* but the water was cold! And I had never drunk the Harlem water before. The mammoth reel of wire and the sledge hammer weighted me down. I thought I would meet the fate of the Dutch rider, and the channel would have to be renamed WJZ-WJY. How I struggled and yelled, churning up the waters of the Harlem like a steamboat, and bouncing my voice against the side of Inwood Hill. Suddenly something snapped. I thought it was my suspenders, but now I know it must have been the twisted pair. After epic exertion, I emerged on the north side of the river, and raced on to make up lost time. I flew past Yonkers, Tarrytown, Ossining, where I glimpsed the warm and well-fed convicts at their evening movie show, and Peekskill. Wet, frozen, and bedraggled, I staggered into Poughkeepsie at 7 o'clock. My WGY colleague sat at the amplifier.

"You're drunk and late," he said.

"Yes," I wept hysterically, "but here are the pair!"

We spliced the wires in silence, and began calling New York. More silence. New York did not answer. Then I realized that the



I start out with a reel of twisted pair

line was broken, grounded and crossed at Spuyten Duyvil. All was lost, including honor! And the next day "Pioneer" razzed us in her column. (A new critic has just been appointed and now rules in Pioneer's place.)

The Memoirs of a Radio Engineer

RADIO is different from all the engineering arts, and has moved faster than any of the others in the last two decades. That is my first excuse for printing these memories now, instead of waiting until I am seventy years old. In the second place, to wait until one is old, before writing anything of an autobiographical nature, is a disparagement of youth. If the experiences of youth are worth anything—and they appear singularly precious to all but the most desiccated of men—surely they are worth setting down at a time when they are still comparatively fresh in one's memory, when some vestige of feeling still clings to them. It is logical, therefore, to write one's memoirs in two sections, one at the age of about thirty, the other after one has passed sixty. The writing of this first section is what I now undertake, in somewhat the same spirit as that which impelled Max Beerbohm to issue his "complete works" at the age of twenty-four.

Two objections remain to be disposed of. The writing of memoirs is, for presumably sound reasons, a prerogative of famous persons, and, indisputably, I am not famous. The answer to this is that such personages will appear in the narrative: I can be Boswell, if not Johnson. Furthermore, only the radio aspects of my career will be illuminated. The last suspicion of impropriety, that involved in the writing of such a history by a man still in the full tide of events, may be met by terminating the story at a point sufficiently far back to allay the apprehensions of the individuals and groups with whom I have fought so recently that they still remember it.

I made an attempt on father's watch

These apologies and reassurances completed, the epic begins.

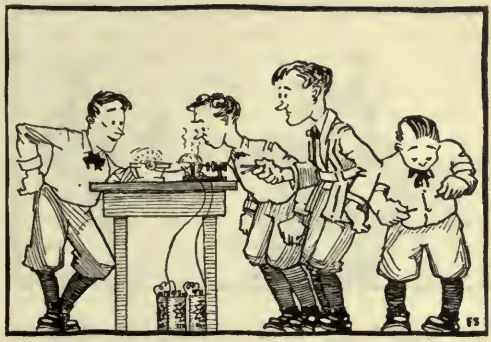
In 1907, when I was about eleven years old, one of the elementary school teachers under whom I was incarcerated delivered to his class a lecture on magnetism, using for illustration one of those small, flat, red-enameled horseshoe magnets which at that time sold for a penny in the stationery stores. At the same time he told the boys a cock-and-bull story about Mohammed's coffin, which, he alleged, was suspended between heaven and earth, without visible support, through the agency of magnetism. This instruction was not a part of the work of that class, I might mention; the teacher was endeavoring to amuse us, during an interlude, in reward for good behavior. At any rate, the next day I bought one of these little steel magnets instead of gum drops, and amused myself magnetizing my mother's knitting needles. I also made an attempt on my father's watch, and, while I did not succeed in imparting to it any appreciable polarization, my efforts were not entirely in vain, for the watch stopped the same day. In my endeavors to suspend a miniature Mohammed's coffin between the magnet and the table I failed utterly. The armature either jumped to the magnet or fell to the table. After a time I gave it up and shot one of my playmates with an air-rifle.

Shortly afterward I became interested in electricity. As yet I did not suspect that magnetism and electricity had any connection. The first attracted iron; the second rang bells. I crawled around in a dark and dusty compartment under the stairs of my home, where the electric battery which rang the bells was located. This battery consisted of sal-ammoniac cells, each with a ponderous carbon cylinder and a zinc rod in a solution of ammonium chloride. Three such cells rang the bells of the house. Dry cells were very well known by this time, but their quality was not then good enough to push wet cells entirely out of the market. For the same reason, partly, the popular use of electric flashlights was practically unknown. The electrical industry has changed remarkably, even in these eighteen years. There were as yet no tungsten or other metallic filament bulbs, and most store windows in New York City were still lighted by Welsbach gas mantles. However, I was not yet interested

in the state of the electric industry. The Leclanché cells in the cellar represented, to me, a kind of magic. I did not know them by their correct name, of course, and in some way I got the idea that they were storage batteries. In due time I went to my parents and asked for a battery for Christmas. I had no clear idea of what I wanted to do with it, but I believed that with a battery one might sustain and impart electric shocks and perform miscellaneous wonders.

My father, then as now, was a business man; he knew nothing about batteries and cared less. However, apparently he realized that a battery alone would not serve my purpose. He bought me a small electromagnetic engine, a little wire, and three dry cells. This engine could be belted, with a rubber band or a piece of string, to a toy buzz saw which, on days when it was feeling good, could cut a matchstick in two. I operated this machine for hours every day, and soon ran down the dry cells. At this time I became acquainted with the odor of ozone, for the remarkable engine functioned with a make-and-break contact at which a fascinating blue spark flashed. All the boys in the neighborhood came to see the spark, to smell the ozone, and to have matchsticks cut in two. I received many flattering trading propositions in connection with this possession—a cannon eight inches long, a dog which the owner swore was capable of speaking several intelligible words, and a wagon with a soap-box body and iron baby-carriage wheels, being among the offers. All were declined.

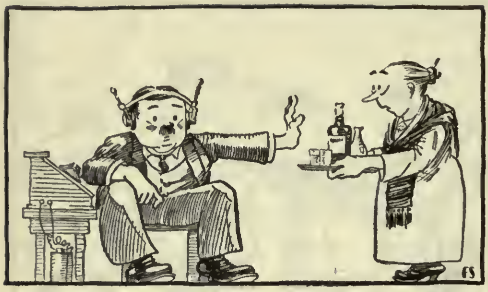
But, among children, as with their elders, the tendency is to grow tired of even the most precious possessions. After a few weeks, the excitement over the electric engine had died down, and it became necessary to seek new diversions. The engine had brought with it the catalogue of an electrical supply firm, and we began to study this. Such books are not only informing in themselves, but, to a boy, they bring up questions the answers to which he must seek elsewhere. What was a make-and-break spark coil, or a polar relay, and how did a burglar alarm work? Four or five of us began to inquire about these matters, more or less urgently. We were lucky because an electrician lived in the neighborhood who had a much greater theoretical interest in his craft than is common; he did not consider us merely as nuisances, which we undoubtedly were, but good-naturedly tried to answer our questions. But he was not our only source of information. In the public



small boys came to smell the ozone

library we found perhaps a half-dozen books of the "boy-electrician" type, written expressly for aspiring juvenile experimenters like ourselves. They contained directions for building voltaic batteries out of tin cans, telegraph sounders constructed of wood and the vital parts of discarded electric bells, and even induction coils which could throw one-quarter-inch sparks. We devoured these volumes and pooled our money to buy wire and 10-cent-store tools. At the same time we were perfectly normal and primitive, we had fist fights, pursued the neighborhood cats with bean-shooters, and played baseball on the vacant lots. If any one had urged us to study electricity we should probably have resisted instruction violently. But, as no one cared one way or the other, we made fairly rapid progress. The main obstacle in our experiments was a well-known ailment of the human race: lack of money.

Most of our energy, on this account, was taken up in finding substitutes for expensive materials. For instance, when I was twelve years old I built an electrophorus. This is an induction device for collecting positive charges on a metal plate, usually of polished brass, held by an insulating handle. In its classical form it consists of an ebonite disc about a foot in diameter. This is electrified negatively by beating or rubbing with a piece of cat's fur. A metal plate of about the same size is set on top of the charged ebonite. The experimenter touches the top of the metal piece. This draws off the negative charge of the same, while the positive charge induced by the ebonite remains bound. The metal electrode is then lifted by the insulating handle. Now let the knuckle be presented to the edge of the metal disc, and a spark about an eighth of an inch long will leap to it with a slight stinging sensation. To me, this



the workman prefers radio to whiskey

was an indescribably dramatic occurrence. Furthermore, by repeating the touch-and-lift procedure, one could draw sparks for hours, on a dry day, without the necessity of rubbing the non-conductor again. This puzzled me. It was not until years later that I understood that I had to work for each spark by overcoming the electrostatic attraction between the charged non-conductor and the metal plate.

My electrophorus was not as aristocratically constructed as the one described above. Instead of ebonite, I used beeswax and rosin in various proportions. I spent at least two months melting and remelting these ingredients over the gas stove in my mother's kitchen, in one of her pie plates donated to the cause of science, in the hope of getting a spark a sixteenth of an inch longer than in some previous attempt. When the composition had cooled, I would flagellate it with a piece of flannel, and set on top of it a wooden disc coated with tin-foil, which had originally sheltered a piece of Liederkranz cheese. The handle was a stick of sealing wax. Nature, however, is impartial. With blind equity, she bestowed her electrostatic sparks alike on me and on the learned professors at Princeton and Johns Hopkins.

(*To be Continued*)

Blame It on Radio. II

THE custodians of the art and industry of the theater, which, according to the eloquent Mr. Brady, is in process of ruin through the intrusion of radio broadcasting, may find comfort in the similar sad plight of other altruists. Other hearts are breaking. The British rum shops are emptied of customers, the libraries are full of books which no one reads, the once lovely maids and matrons of Germany become the despair of beauty specialists. We reprint the evidence so that our readers may join in the universal lamentation:

PREFER RADIO TO WHISKY

British Workers are more Sober, Salvation Army Finds

LONDON, Feb. 26.—The British workman of today prefers wireless to whisky and Bunyan to Barleycorn, Captain Charles Nicholson of the Salvation Army told the Finsbury justices at their meeting to consider liquor license renewals.

"Drunkenness has been reduced by one half during the last few years," said the Captain, "and many public drinking houses are often empty on Sunday evenings."

—New York *Times*, Feb. 27, 1925

RADIO REDUCES DEMAND FOR LIBRARY BOOKS

It has been said that the new and increasing interest in radio work has caused a falling off of interest in the libraries of England. The Middlesex Library Committee reports that for November of last year there were over five thousand fewer books taken from the library than during the corresponding month of the year before. Even the work of the conference library was lessened by 20 per cent. during the same time.

—New York *Sun*, Jan. 16, 1925

"RADIO WRINKLES" MAR FAIR LISTENERS' FACES

By the Associated Press

BERLIN

Radio wrinkles are the latest bugaboo of German women, who see their faces marred by folds and creases brought on by the strain of listening to wireless programs. Beauty specialists affect to find that the faces of female radio fans acquire a strained expression from listening night after night to the radio.

Their brows become knitted, their lips firmly pressed together and their whole expression hardened and less womanlike, say the beauty experts. The consequence is what is called the "radio face," of which the chief characteristics are radio wrinkles.
—New York *Herald-Tribune*, January 4, 1925.

As a professional broadcaster, practicing his art and mystery in the United States, I derive a certain comfort from the last item, which may be set against my grief at seeing the sum total of female pulchritude in the world diminished. May one not infer from this despatch that the German broadcast programs are even worse than the worst American efforts?

Oliver Heaviside

HOW many people who own radio sets heard of, much less heeded, the recent death of Oliver Heaviside, referred to in the current issue of the *Journal of the A. I. E. E.* as "an illustrious successor to Wheatstone, Maxwell, and Kelvin." Probably not as many as would regret the passing of some self-styled radio expert who never did anything better than write meaningless letters after his name, revamp in disguised form the inventions of better men, turn out a few trashy magazine articles, and plug himself in the Saturday radio supplements. That is the way of the world.

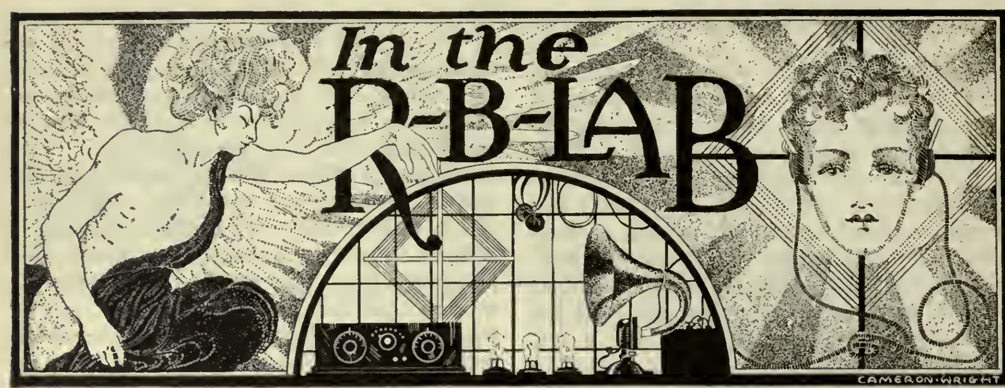
For Heaviside never tried, in the phrase of the day, to "sell" himself, to be popular and recognized. He was of the stature of the greatest figures of mathematical physics, and what he wrote was not adapted to the needs of the kindergarten or of the consumers of predigested mental foods. No editor of a tabloid newspaper ever printed his photograph beside that of some distinguished movie actress who had just shot her latest lover, not only because no tabloid newspaper editor ever heard of him, but also because few photographs of Heaviside existed. In his reluctance to be photographed he resembled a great American, Henry Adams, a man of somewhat less originality but not dissimilar temperament.

Heaviside was an Englishman. He wrote occasional articles for the *Philosophical Magazine*, the *London Electrician*, and other learned journals. He applied his mathematics, in which he was not much less adept than Newton or Leibnitz, to such problems as the propagation of electrical waves along wires, the distributed constants of telephone lines, and the development of the electromagnetic theory generally. His papers are inordinately hard to read. This being called to his attention on one occasion, he answered sardonically that they were even harder to write.

His work had very practical consequences. The fact is that the Armstrongs, the Poulsens, the Heisings, the De Forests, stand on the shoulders of the Maxwells, the Hertzs, the Rayleighs, the Websters, and all the other dreamy investigators who live in a shadowy mathematical universe and write incomprehensible articles instead of selling real estate and trying to make enough money to buy a Packard. The engineers and inventors deserve all the credit they get, but it should not be forgotten that they owe their eminence and high visibility to the pure physicists who bear them up. In the case of Heaviside, it is a matter of common knowledge that Dr. Pupin's work in the loading of telephone lines was largely the conversion into physical facts of the British investigator's abstruse generalizations. The result was a clarification of speech and extension of range on telephone circuits, reputed, at the time, to be worth a few million dollars to the telephone companies, and probably second only to the development of modern equalizers and electronic repeaters in the expansion of the telephone art—which includes radio broadcasting and the tying up of broadcasting stations by wire lines—this last for the benefit of those radio listeners who don't see what Heaviside has to do with them. Pupin himself is a rare combination; he is equally at home as a mathematical physicist and as an engineer and inventor. He did not complain that Heaviside's articles required hard work on the part of those who read them; he did the work and collected his royalties. Personally, I am frank to say that I never had the brains to read Heaviside, but I have the sense to raise my hat.

Heaviside was deaf all his life, and because of that and no doubt other causes he was as shy and seclusive as Darwin, who could not take an ordinary railroad journey without the most profound agitation. He lived alone in a small cottage in Torquay, which is in Devonshire on the English Channel. He was extremely poor, and in his last years subsisted on a pension of £200 a year. Nevertheless, he was seventy-seven when he died. There is nothing to show that he cared one way or the other about either circumstance. What could such ephemeralities mean to a Heaviside?

they stretch their arms and boast



SIMULTANEOUS OR TANDEM TUNING

AGAIN something new that is not new has come up in radio. In September, 1910, John V. L. Hogan filed a patent application for the "tuning of circuits." The application stated that the primary object of the methods described was to render the manipulation of the tuning elements more easy and accurate. Mr. Hogan goes on to state the specific case of two or more tuned circuits having the same values of inductance (electrically identical coils and wiring), shunted by the same capacities in variable condensers, which can be maintained in resonance (tuned to a common wave), throughout the entire range of the circuits by varying the capacities "similarly and simultaneously." Mr. Hogan suggests, "The component parts of capacities C2 and C3 (the two condensers) can be mounted on the same movable support." This patent was granted twenty-eight months later. Twelve years afterward, several companies appreciating the possibilities of simultaneous tuning, built condensers with two or more sets of stator plates, and with the rotating plates mounted on a single shaft—"the same movable support." These manufacturers were somewhat surprised to find themselves antedated by a decade and more.

> *The Lab Offers You This Month*
>
> ARTICLES ON
>
> *—Simultaneous tuning of two or more circuits with tandem condensers—Pointers that may save you months of experiment.*
>
> *—The second step in the Lab system of remedying radio troubles.*
>
> *—How to build an efficient and simple loop.*
>
> *—A modification of the Knockout Amplifier.*
>
> *—A safer and better way of connecting most loud speakers.*

The experimenter who is seriously interested in this excellent arrangement will find invaluable the theoretical considerations treated in Mr. Hogan's patent No. 1,014,002, and is strongly advised to study it. The enthusiast who does so will be less prone to fall for the incorrect arguments that prevail to-day among the advocates of simultaneous tuning. One of the principal misconceptions among these is the idea that any lack of matching in the coils can be compensated for by the use of verniers across the condensers. This is not the case, for if this is done, a balance is achieved only for one setting of the main condensers, and it is lost with the next variation of the tuning control. Sets employing such verniers take advantage of the simultaneous tuning effect only approximately, and the verniers in many cases are really separate controls.

To achieve simultaneous tuning of two or more circuits the inductance values must be the same. Also, the capacity values must be the same and varied similarly. This last provision is not so difficult. Any condenser carefully constructed will have identical capacities (or sufficiently near to them) at the same degree of turn. The circuit-inductance discrepancies are more difficult to balance, and experiments in the R. B. LAB show them to be the real problem associated with simultaneous tuning. These inductive differences are caused by the difficulty of winding r. f.

transformers to exactly similar inductance values, and the unequal effects of wiring which even the most scrupulous care will not always eliminate.

Fig. 1 shows the conventional two-stage tuned r. f. circuit, with potentiometer control, adapted to simultaneous tuning. It will be observed that the tandem condenser is used on the last two tubes, one stator to the second r. f. stage, the other to the detector secondary, and the common rotor shaft to the negative A battery terminal. A single condenser tunes the first stage, r. f. Due to the presence of the antenna primary coil, which is generally closely coupled to the secondary of the first stage, the inductive discrepancies which we are endeavoring to avoid are generally introduced in this coil. For this reason a single control (one shaft and three rotors) is not advised in a first attempt at tandem tuning. Also, in the author's mind, a two control set is the more logical and desirable arrangement.

The grid leak is returned to positive side of the filament to provide the desirable detecting bias.

The circuit should, it is needless to emphasize, be wired with care to maintain r. f. leads at similar inductive values, i. e., the same lengths and spacing from metallic parts. If the experimenter is successful in this, and the condenser and coils are matched, no further adjustments will be necessary, and Fig. 1 represents the most simple and ideal arrangement.

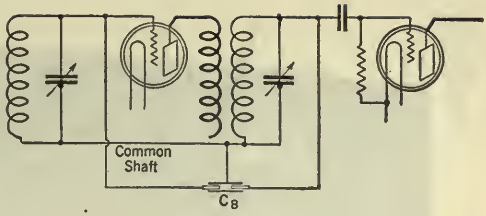


FIG. 2

A neutrodyne stabilizing condenser, C2 is convenient for correctly balancing the capacities of the two circuits

Should the inductances, however, not be balanced as will probably be the case, they must be matched by additional adjustments. The simplest method is to apply copper shielding to the coil with the highest wave, a fact that can be located experimentally. This will lower the wavelength of that coil. Shielding is easily applied by rotating a disk (cut from $\frac{1}{32}$-inch copper sheet) slightly smaller than the diameter of the coil, in the field of the coil as you would a tickler. Or, strips of the metal cut into semi-circles, can be clamped on the outside of the secondary, the width of which will determine the amount of inductive variation.

If these experiments fail to result in satisfactory resonance throughout the entire tuning range, it is probable that the capacities are slightly off balance due to wiring, etc. This can generally be remedied by connecting a condenser designed for neutralizing circuits

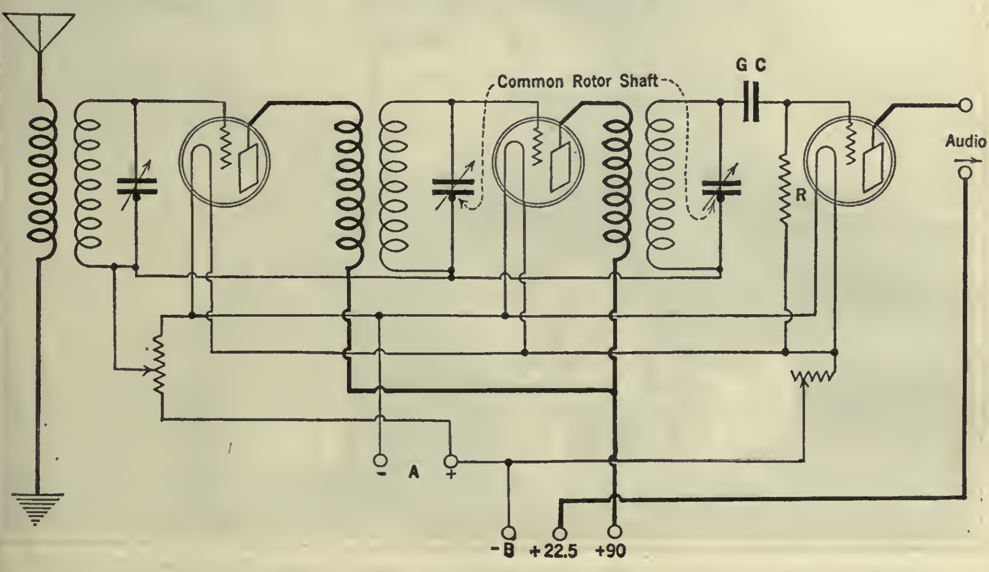


FIG. 1

Simultaneous tuning of the conventional r. f. circuit. Note the grid condenser-grid leak connections

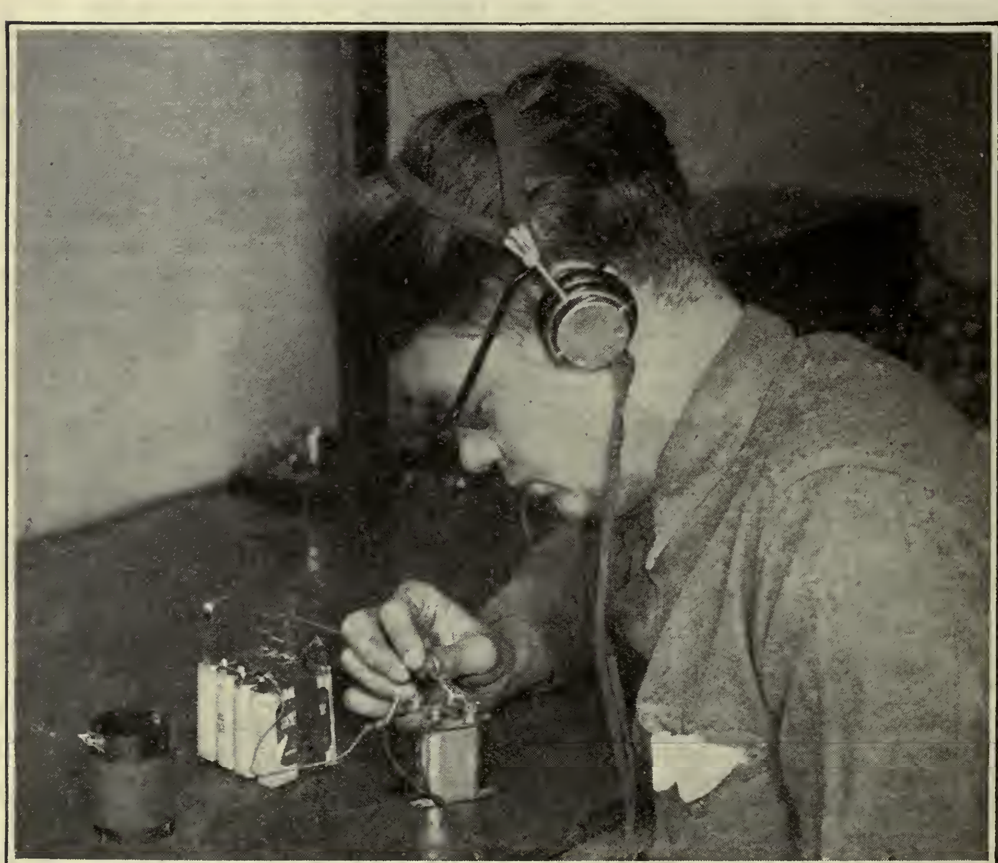
RADIO BROADCAST Photograph

FIG. 3

Type of "tandem circuit" sets experimented with in the R. B. Lab. Three circuits and one dial is considerably more difficult than the two control arrangement

as suggested in Fig. 2. A condenser of this type consists of two separated metal rods, covered by a glass tube, over which is clamped a movable metal clamp. Moving the clamp or slide will throw the extra capacity to the correct circuit.

Simultaneous tuning may be adapted to any form of circuit. Even three or four cir-



RADIO BROADCAST Photograph

FIG. 4

Coils, transformers, and condensers are easily tested in respect to "opens" or break down with a small battery and ear phones

cuits can be controlled with one dial, if the arrangement is effected with expert nicety. With more than two stators, shielding is generally necessary between and around the stators to reduce undesirable capacity effects. Elementary shielding is illustrated in the single control set in Fig. 3.

SHOOTING TROUBLE
PART II

WE DISCUSSED last month a logical and efficient system for locating the "trouble area," in the various cases of a receiver becoming inoperative. When the difficulty has been located, the remedy is generally obvious and simple. Running in the same order as the tests, the following are the logical curative processes:

A BATTERY

IF THE battery is found to be low, recharge it. Replace broken leads with new wire. Corroded terminals should be scraped, sandpapered, and coated with vaseline. Should hydrometer readings show a repeatedly low drop and short life in one cell, the battery should be taken to a dealer for examination. Rheostats can usually be repaired.

B BATTERY

Replace or short out low cells or batteries.

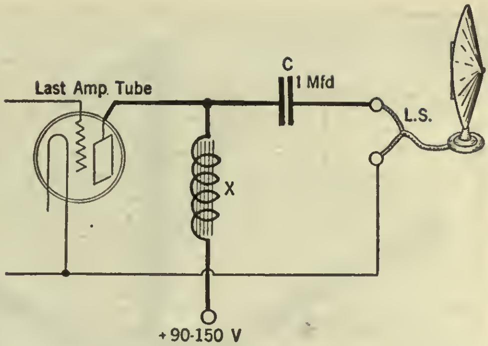


FIG. 6

A better way of connecting your loud speaker, without decreasing volume. This diagram offers several advantages

AUDIO FREQUENCY AMPLIFIER

JACK prongs and sockets bear the first inspection. Pressing up or down with a pencil or a strip of wood will locate a faulty spring, which may be permanently bent into place.

The cure for broken connections in any part of the set is obvious. Knocking about the bus-bar with a pencil will often locate a break (generally at a soldered joint) which has before eluded a painstaking search.

Opens or breaks occasionally occur in the flexible leads to audio frequency transformers. Transformers and coils are easily tested for opens, with a small battery and a pair of re-

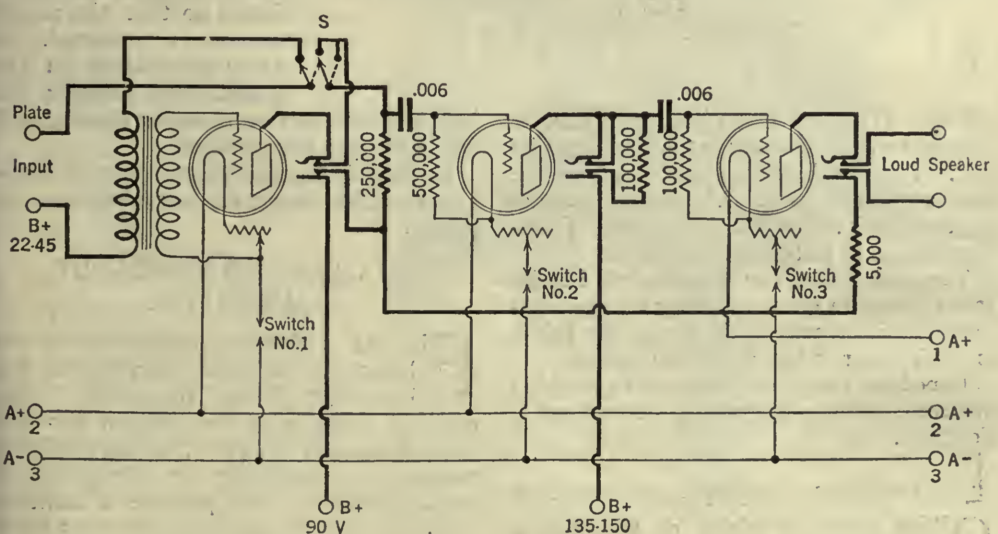
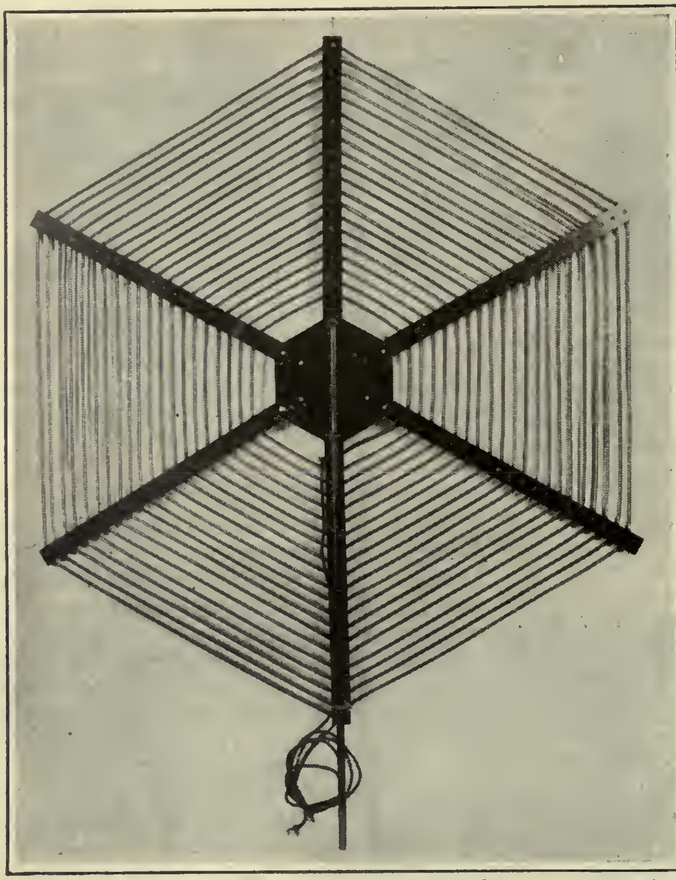


FIG. 5

The improved Knockout amplifier circuit. Volume control by the elimination of the transformer is effected by the rotary switch, and the extra A battery post facilitates the use of an 8-volt power tube in the last stage



Radio Broadcast Photograph

FIG. 7
The completed loop from the rear

Broken down bypass condensers should be replaced with new ones.

TUBES

A BAD tube is generally incurable. Once in a blue moon a hard knock with a pencil will help matters, but a replacement is generally the only recourse.

PHONES AND LOUD SPEAKER

LEADS are simply replaced and terminal breaks can be resoldered with resin core solder. Breaks in the windings are best referred to the manufacturer for repair.

ANTENNA AND GROUND

IF THE trouble is traced to the antenna or the ground, most of the remedies are obvious. If the antenna is down, there is but one thing to do. If the lead-in is short-circuiting against part of the building, the leads should be readjusted so that the proper tension is preserved. If there is a break in the ground lead soldering the broken connection or replacing the damaged wire will solve this problem.

In the July Radio Broadcast, we will discuss remedies for the receiver when it works poorly.

ceivers. (Fig. 4). One phone-cord runs to the battery, and the other to the winding under test. The remaining connection is from the winding to the battery. A loud click on breaking the circuit indicates a perfect coil. Transformers can be tested while in the set.

Terminal breaks can be soldered, but interior breaks in the transformer winding cannot be easily repaired. In a case like this it is much better to buy a new transformer.

Impedances and resistances can be tested in the same manner, and should be replaced if defective.

RADIO FREQUENCY AMPLIFIER AND DETECTOR

OPEN circuit in wiring or windings in radio frequency transformers, can almost always be soldered with comparative ease. Potentiometers may be repaired or replaced according to the ability of the experimenter.

AN IMPROVED KNOCK-OUT AMPLIFIER

FIGURE 5 shows a modification of the Knockout amplifier described in the December Radio Broadcast. The essential variation of this diagram from the original circuit is switch "S," of the two-blade rotary type permitting the elimination of the transformer. This provides a desirable volume control in the many instances when the intensity delivered by the full complement of tubes is excessive. With the transformer out, the amplifier functions as two stages of straight resistance coupling. Because of

this, best results will probably be secured by using a 100,000-ohm resistor as a coupling resistance in the first resistance-coupled stage rather than the 250,000-ohm unit recommended in the original article. The suggested values hold for the remainder of the circuit.

In Fig. 5 a further modification will be noted in the provision of a separate binding post for the positive filament terminal of the output tube. This provides for the use of a UV-202 or similar power tube in the last stage. This tube requires a lighting potential of eight volts for most efficient operation. When so used the six-volt leads run to posts 2 and 3, while the eight-volt lead or tap is connected to post No. 1. When six-volt tubes are employed throughout, posts 1 and 2 are birdged over.

This amplifier may be added to any receiving set, immediately following the detector or reflex tube. For additional details, the interested reader is referred to December, 1924, RADIO BROADCAST.

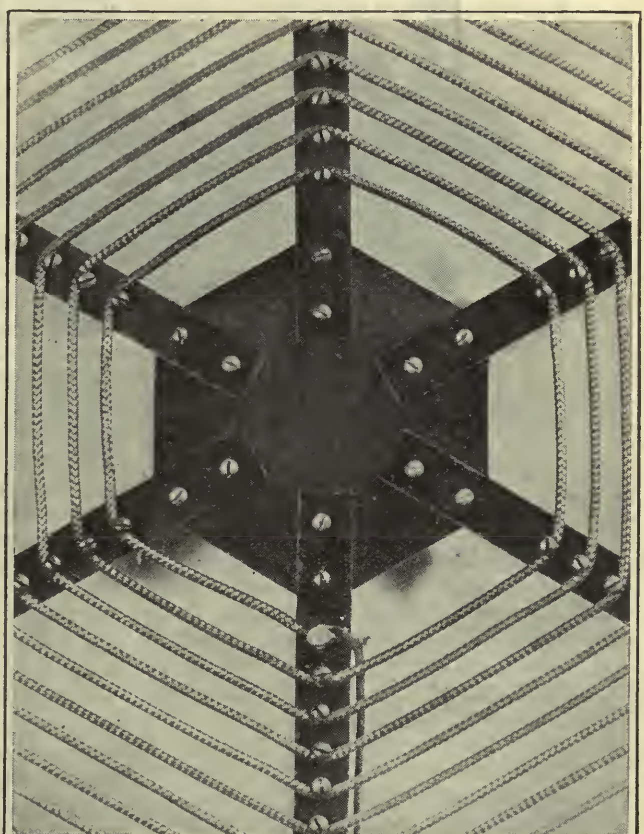
A BETTER LOUD SPEAKER CONNECTION

IN MANY cases, from the standpoint of general results, it is incorrect practice to connect the loud speaker directly in the plate circuit of the last or output tube of the amplifier. Such a connection is usually recommended by the manufacturer because of its simplicity. The improvement suggested in Fig. 6 is offered to the fan who has been graduated from his first book of instruction.

The diagram represents the last stage of any amplifying system: resistance, impedance, or transformer coupling, and its output, the loud speaker. The additional parts required are the choke, "X", and the one-microfarad condenser C. Reactance "X" can conveniently be the secondary of an ordinary amplifying transformer. It will be observed, and herein lies the variation from the conventional, that the loud speaker is not in the plate circuit proper, but its place is taken by the choke coil. The audio results are of the same intensity as those outputted by the more usual arrangement, with the following advantages:

Only alternating current, the sound-producing variations, passes through the speaker windings. This removes the stress of a strong magnetic attraction on the diaphragm, a strain that often results in a rattle when strong signals are coursing through the windings. The loud speaker windings are also safeguarded from induced surges when the plate circuit is suddenly opened, or the stress resulting from short-circuited tube.

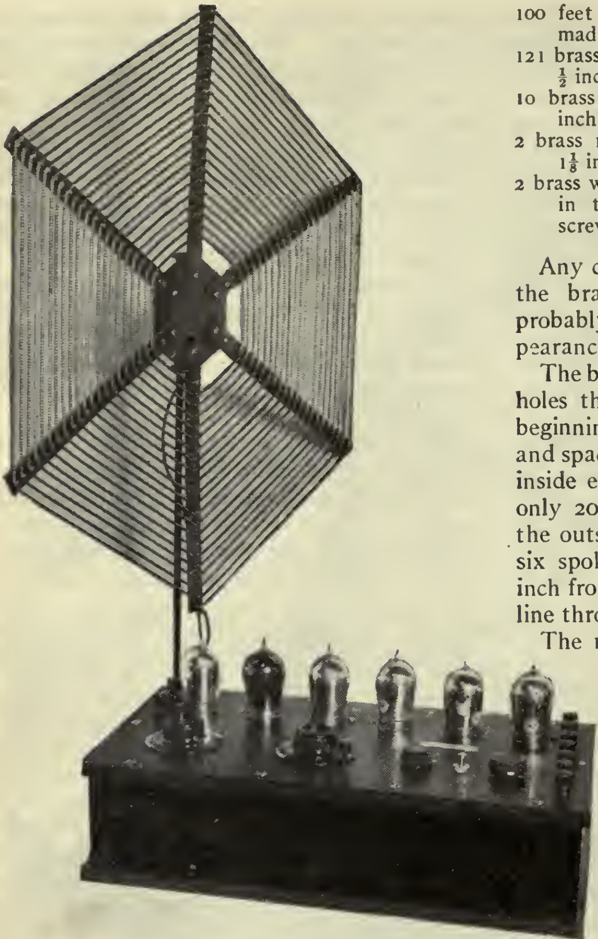
There are, however, a few loud speakers, especially designed for inclusion in the direct plate circuit, and which work better in that position. These instruments generally place importance on the polarity of connections. In Fig. 6, no consideration is given to polarity.



RADIO BROADCAST Photograph

FIG. 8

The center construction of the loop. Any convenient wire below No. 20 can be substituted for the braid



Radio Broadcast Photograph

FIG. 9

An attractive and efficient coil antenna

A UNIQUE LOOP

MANY descriptions of receiving sets take the loop a little too much for granted, merely specifying it as the correct antenna, and leaving the details to the imagination of an often inexperienced radio constructor. The loop pictured in Figs. 7, 8, and 9, will function very satisfactorily on all loop receivers and will cover the broadcast band when shunted by a .00035 mfd. variable condenser. Its form is somewhat unique and its qualities excellent. The following parts were used in making this loop:

6 pieces of Formica, or hardwood, 12 inches long, $\frac{3}{4}$ inch wide and $\frac{3}{16}$ inch thick.
1 piece of Formica cut in the shape of a hexagon, $4\frac{3}{8}$ inch from face to face and $\frac{3}{16}$ inch thick.
1 piece of brass tubing or rod 20 inches long and $\frac{1}{4}$ inch in diameter.
100 feet of Springfield 16-strand braided copper, made at Springfield, Mass.
121 brass round head machine screws, $\frac{8}{32}$ or $\frac{8}{24}$, and $\frac{1}{2}$ inch long.
10 brass round head machine screws $\frac{6}{24}$ and $\frac{3}{8}$ inch long.
2 brass round head machine screws $\frac{6}{24}$ inch and $1\frac{1}{8}$ inch long.
2 brass washers about $\frac{1}{4}$ inch thick and with a hole in them large enough for the $\frac{6}{24}$ machine screws to go through.

Any convenient wire can be substituted for the braid. No. 18 annunciator wire will probably give quite as good results, though appearances may suffer slightly.

The bottom spoke of the loop should have 21 holes threaded in it with an $\frac{8}{32}$ or $\frac{8}{24}$ tap, beginning one half inch from the outside end and spacing the holes one half inch toward the inside end. The remaining five spokes have only 20 holes beginning one half inch from the outside end. From the inside end of all six spokes tap two holes, the first $\frac{3}{8}$ of an inch from the end and the second $1\frac{1}{8}$ inch on a line through the center.

The rest of the story is told in the photographs. Fig. 7 details the control construction and the manner of winding. Fig. 8 is a rear view of the complete loop, which Fig. 9 shows in operation.

SOLDERING has been a problem of the radio fan for some time. The acid fluxes and pastes that facilitate a creditable joint in the more strenuous trades are taboo in radio construction. Acid corrodes the delicate wires, and, like the conventional pastes, works its way into places where it introduces leaks with accompanying noises. The R. B. Lab has had great success with an excellent non-acid soldering fluid manufactured and sold by John Firth and Company, New York City.

THERE are four or five different sizes of B batteries available to the radio experimenter, and it is often a puzzling question as to which size is the most economical in the long run. The ultimate economy is determined by the number of tubes, and where the batteries are to be used (r. f., a. f., etc.), B battery voltage, C battery, and the amount of usage and the individual characteristics of the tubes themselves.

If you replace your B batteries more often than every three months, it will be profitable for vou to change to a larger size.

Some Facts About Sound Waves

How They Are Produced and How They Are Analyzed —The Laws That Govern the Action of Sound

BY B. F. MIESSNER

SOUND, as radio experimenters who have had a hand in developing communication by radio telephony have discovered, is a subject deserving of much study and experiment. Broadcasting, after all, is merely the transference of sound from a broadcasting studio to the listener. We are using radio means to accomplish this, and many devious electrical paths does the sound follow before it emerges from the loud speaker of the radio listener. A good broadcast engineer has to devote almost as much of his attention to sound as he does to the actual radio mechanics of its transmission. Mr. Miessner in these articles is attempting to tell the important physical facts about sound. In his first article (RADIO BROADCAST, for January, 1925), he told of the importance of sound in the cosmic system and its particular relation to radio. His second article in the April RADIO BROADCAST was a discussion of the basic physical facts about sound. This article continues the discussion and includes some excellent photographs and diagrams of sound waves. This discussion of Mr. Miessner's, while somewhat technical, has a direct and important bearing on radio broadcasting.—THE EDITOR

THE sound waves we hear are produced by minute variations in the normal pressure of the atmosphere. The crests of these waves are called condensations, because in them the air is condensed or compressed. In a graphical analysis they are shown as the positive halves of the wave graph. The hollows of the waves are called rarefactions, because in them the air pressure is lessened or rarefied; these in graphical analysis are shown as the negative halves of the wave graph.

The actual variation in pressure constituting sound waves is very small indeed compared with normal pressure. While measurements of these variations are very difficult to make because of their extreme minuteness and fleeting nature, the most reliable results thus far indicate that the ear can hear a sound having an amplitude or pressure variation of only one one thousandth of a dyne per square centimeter. The actual pressure variation of the weakest audible sound is about one part in ten billion—in terms of the normal atmospheric pressure of nearly fifteen pounds per square inch. A pressure variation of one thousand dynes per square centimeter, which is one million times the minimum audible variation, is painfully loud and represents the high intensity extreme ordinarily encountered. Extremely loud sounds then,

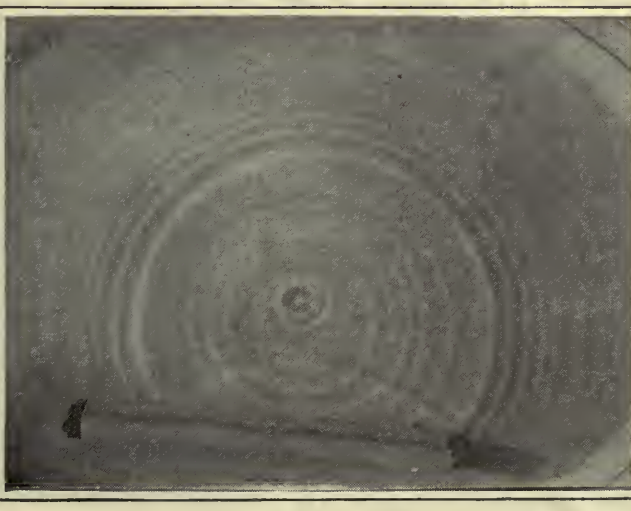


FIG. 1

A photograph showing the reflection of a circular water wave by a plane surface, such as a straight sea wall

FIG. 2
The photograph shows the reflection of a circular water wave by a curved surface as a curved sea wall

are produced by pressure variations of only one ten thousandth part of the normal atmospheric pressure, or, in actual pressure, about .0015 pounds per square inch. There is no pressure gauge which will measure such small variations of pressure. Some indication of the delicacy and sensitivity of the human ear may be gained by these facts.

SOUND WAVE PICTURES

PHYSICISTS have long used a kind of topographic map to indicate the sound waves in a given locality. As the civil engineer shows high lands by closely spaced lines and low lands by widely spaced lines, and connects all points of equal elevation by these lines, so the physicist has used such lines to indicate the regions of high and low pressure forming the condensations and rarefactions of sound waves. The actual photographs of spark waves published in a previous article of this series (RADIO BROADCAST for April), show these same effects very clearly and beautifully. Refraction shadows of water waves also show them very clearly.

As the result of much experiment, the writer has succeeded in developing an exceedingly simple method of producing and photographing water waves, which illustrate perfectly the effects of sound waves and the laws determining their behavior. Several of these photographs are reproduced herewith, and numerous others will be used in succeeding articles.

While these representations of sound waves are valuable in aiding the understanding of acoustic phenomena, and particularly in tracing qualitatively the effects of reflection, refraction, absorption, diffraction, and other important characteristics, a more accurate method is necessary for quantitative representation and analysis. If we take an instantaneous cross section of a simple water wave, we may get a picture like that shown in our illustration. Such views of waves may be obtained in aquariums, where a plate glass window constitutes one side of the tank, and permits observation of the fishes inside. The wave is seen here as variations of height from point to point above and below the normal water level.

If we place a pressure measuring device at P and measure the pressure of the water at that point at equal time intervals as the wave passes overhead, we may construct a curve or graph with rectangular coördinates, which will show the variations of pressure with time, as the illustration shows. If the point P moves downwards, thus increasing the normal or steady pressure of the water, the axis of the curve will move upwards, and vice versa, but the wave itself will remain unchanged, being shifted up or down accordingly. The vertical

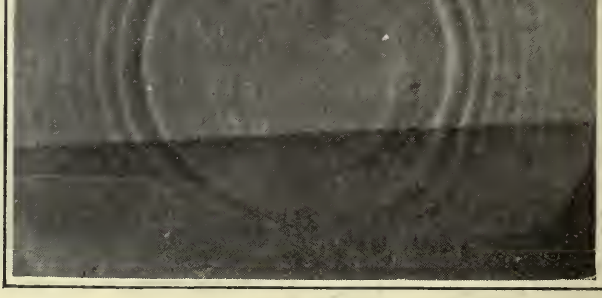


FIG. 3
How a circular water wave is absorbed without reflection by an inclined surface such as a sandy beach

lines or *ordinates* represent pressure, the horizontal lines or *abscissae*, represent time. Such representations of waves, or in fact any kind of variation, are quite common and serve a very useful purpose in study and analysis.

THE PHYSICAL CHARACTERISTICS OF SOUND

SOUND waves, like alternating currents, are classified and described physically according to amplitude, frequency, length, and form.

Amplitude. The amplitude of a sound wave refers physically to the actual increase above or decrease below the normal atmospheric pressure at the crest or hollow respectively. It is usually expressed in terms of dynes per square centimeter although for convenience, any other units of force and area may be used. The amplitude is related to the volume or loudness of a sound. But while the loudness increases with the amplitude, the relation between them is not simple or linear. The loudness is more closely related to what the physicist calls the *energy* of the vibration. The physical energy of a simple vibration is proportional to the square of the amplitude. This expresses a general law true for all kinds of vibratory energy. To illustrate: If several similar waves have amplitudes of one, two, and three, their respective energies will be in the ratio of one, four, and nine.

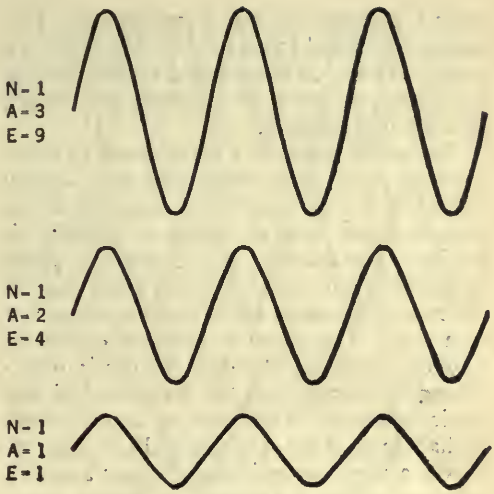


FIG. 5

Waves of similar frequency, but of differing amplitudes. This drawing shows that the energy of a simple wave is proportional to the square of the amplitude, the frequency remaining constant

While the physicist must use such interpretation in his study of the physics of sound, the psychologist knows that the ear does not respond with a loudness sensation strictly proportional to the physical energy of the impressed sound. There is a general law familiar to the psychologist as Weber's law, which has been verified approximately for most of the senses, and which states that the sensation produced by a sense stimulus is proportional to the logarithm of the physical energy of that stimulus. That is to say, if the loudness of a given sound be increased from 1, to 5, to 10, the actual energy would be increased accordingly from 1, to 150, to 22,500. The corresponding physical amplitudes would be the square roots of these latter values, or, 1, 12, and 150.

This law, while not accurately true, and varying considerably for different ears, is nevertheless important and must constantly be borne in mind in radio. For example, if a loud speaker must be made to give five times as much sound intensity or volume, it must be provided with about 150 times as much energy in its actuating current!

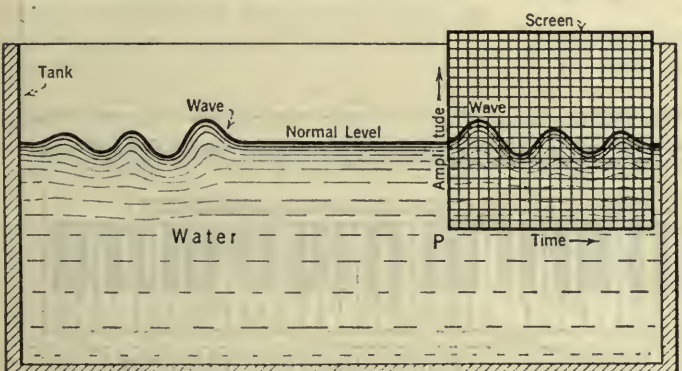


FIG. 4

A sketch of a water wave as seen through the glass side of a tank, showing the wave in cross section. If one view the wave on one side through a cross section screen as indicated, with its lower left hand corner on P, the wave appears as a graph on the rectangular coördinates. Moving P and the screen up and down merely moves the curve oppositely on the chart without changing the wave form

SOUND WAVE FREQUENCY

THE frequency of a sound wave, like the frequency of any other wave, may be stated as the number of similar waves passing a given point in a second. The term *wave* de-

notes a compression and a rarefaction. Frequency in general terms refers to the pitch of a sound. Grave or low-pitched sounds are low in frequency; shrill or high-pitched sounds are high in frequency.

The lowest sound on a piano tuned to international pitch is 27 vibrations per second; middle C is 259, and the frequency of the highest sound is 4138 cycles, or double vibrations, per second. Fig. 6 shows a piano keyboard tuned to international pitch and the corresponding sound pitch and wavelength of each key. The piano is thus an extremely valuable frequency standard for use in determining by comparison the frequency of any musical sound. While not so accurate and unchanging as a set of tuning forks, it is nevertheless a very convenient and fairly accurate standard which is available in almost every home. The piano strings, of course, sound many overtones, so that each key actually produces a number of sounds besides the lowest or fundamental vibration. These are exact multiples of the fundamental. Inasmuch as the fundamental tone characterizes the pitch as we hear it, we need not concern ourselves with the overtones in such pitch comparisons for determining the vibration frequency of some other sound source.

The normal human ear will detect sounds of frequencies as low as 16 and as high as 20,000 cycles per second. The actual limiting frequencies depend largely on the intensity of the sounds themselves, the limits extending with the loudness of the test sounds; for example, with very weak sounds the limits might be 20 to 15,000 cycles—for very strong sounds 12 to 25,000 cycles.

SOUND WAVELENGTH

THE length of a sound wave is the distance between successive waves measured from corresponding points. If the frequency be known, the wavelength may be computed by dividing the frequency into the velocity of propagation. Thus, a sound having a frequency of 100 double vibrations (cycles) per second has a length of 1090 divided by 100, or 10.9 feet.

In general, these relations are represented by the equation $V = NL$, where V is the velocity, and L the length of the wave. By using $V = 300{,}000{,}000$, the velocity of radio waves in meters per second, N in cycles per second, and L in meters, the wavelength or frequency of any radio broadcast wave may be computed similarly, providing one of these factors be known.

The loudness sensation of sounds having the same physical amplitude but differing in frequency (i.e., wavelength), is not the same. It requires a much greater amplitude in low than in high tones to produce a given loudness sensation. This curious fact may easily be observed in a piano. The large, low-toned strings move visibly and strangely with a circular kind of motion, the higher strings vibrate less visibly, and the very highest cannot be seen to vibrate at all. And yet all of the strings emit sounds of about the same loudness.

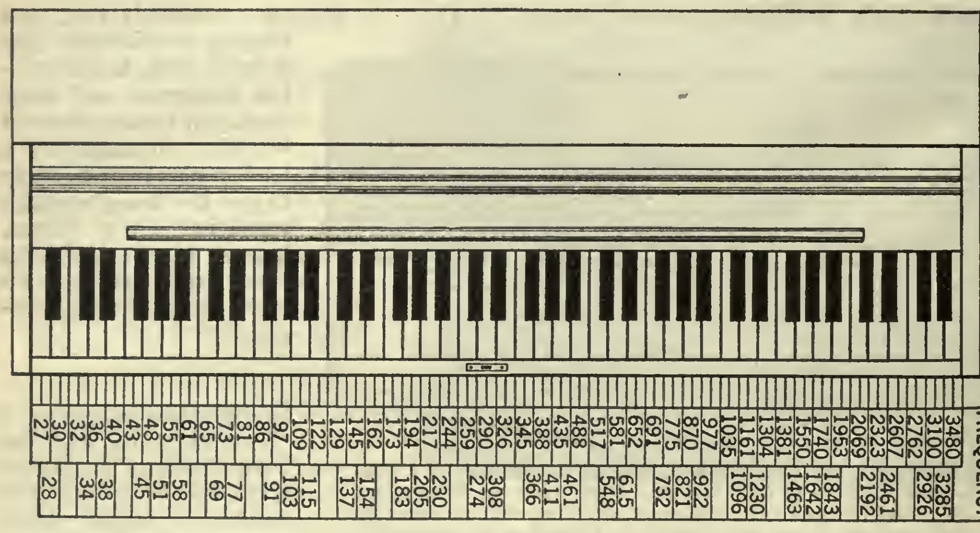


FIG. 6

The frequencies and corresponding wavelengths of the sounds produced by the keys on a piano

The physical law, true for all vibratory energy, states that the energy of the vibration is proportional to the square of the frequency, the amplitude remaining constant. To illustrate: Three sounds having equal amplitudes but unequal frequencies such as 100, 200, and 300, would have physical energies in the relation of 1, 4, and 9. The actual perceived loudness, however does not follow this physical law closely. While a detailed analysis of the perception of sound is not properly a part of a physical discussion, and will be reserved for a later article, it may be stated in passing, that, for equal energies the ear hears very high pitched sounds louder than very low ones, and mid-range sounds louder than either high or low. We can hear sounds of wavelengths between about 68 feet (i.e., 16 cycles) and 0.65 inch (i.e., 20,000 cycles). When both the amplitude and frequency vary, the energy is proportioned to the product of amplitude squared and frequency squared.

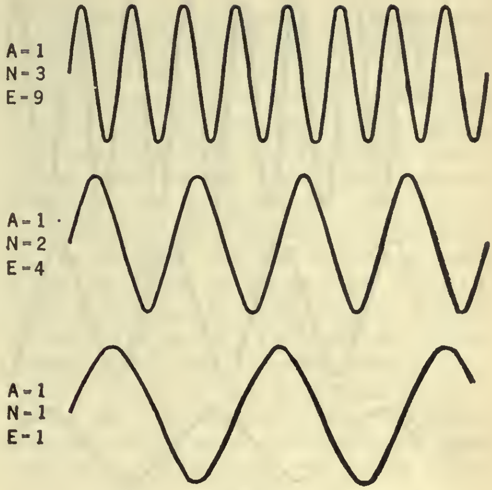


FIG. 7
Waves of the same amplitude, but of differing frequency. The energy is shown here as proportional to the square of the frequency when the amplitude is the same

THE WAVE FORM OF SOUND

THE only form of wave thus far discussed is that of the simplest possible type which is known as the curve of sines, or more generally as a sine wave. Its mathematical derivation need not be introduced here. This type of wave in sound, while valuable as a basis for analysis, is really an extremely rare phenomena.

The sine-wave sound is called a pure sound or tone, meaning that it consists of but one vibration frequency; it has no overtones. The purity of a tone refers to its freedom from overtones, and not to any æsthetic quality which this expression is sometimes meant to convey. A pure tone is extremely uninteresting musically.

The sounds of nature, of music and of speech, are always relatively complex in this sense. Your voice in speaking or in singing what you think is a single tone may consist of twenty-five or more component simple tones, extending upwards in frequency from the fundamental or lowest frequency vibration to the highest overtone detectable by the human ear. A few musical instruments, such as the flute, the French horn, and certain types of organ pipes, can be made to produce nearly pure sounds, in which most of the emitted energy is concentrated in one frequency, but a few weak overtones are always present.

Complex sounds consisting of many component partial tones, do not have the simple wave form of the pure sound. Instead, the wave form, like the sound itself, is very complex. Fig. 9 shows such a wave form representing the complex sound of a single organ pipe. The frequencies, amplitudes, and energies of all the partial simple tones in this sound, as tabulated, completely describe the sound itself, except for what is known as the phase relations of the components, which is a matter of secondary and even doubtful importance. The energy column is calculated from the other two. The sum of the energies of the separate component partial tones is the total energy of the whole sound.

FINDING THE WAVE FORM OF SOUNDS

THE wave forms of various sounds can be photographically recorded by an instrument known as the oscillograph. The electrical oscillograph when used in conjunction with special microphones and amplifiers such as are now used in high-quality broadcasting, will produce a visual moving picture or a photographic record of the wave form of any sound impressed on the microphone.

Professor Dayton C. Miller, of the Case School of Applied Science, about ten years ago devised a remarkable type of sound oscillograph which he calls the "Phonodeik." This ingenious instrument permitted him to record the wave forms of many different types of sound and to analyze their records at leisure. By his skillful mathematical calculations, the slight distortion of the instruments could be corrected and the true wave form of the recorded sound developed.

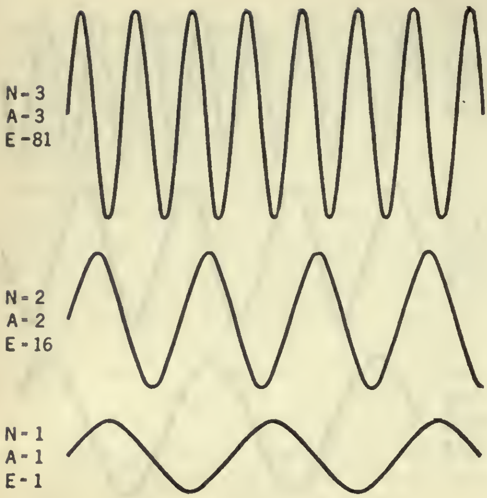
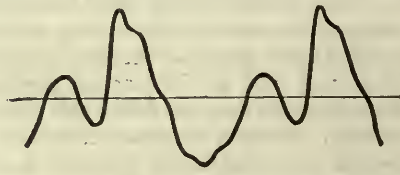


FIG. 8

Waves whose frequency and amplitude are both different. The energy is here shown as proportional to the product of the amplitude squared and the frequency squared

Once the wave form is obtained, it is possible for sounds with only harmonic components (that is exact multiples of the fundamental frequency) to analyze the wave and to determine exactly what simple waves it contains; it is further possible to determine the relative frequencies and amplitudes of all the component partials. This may be done by a rather laborious mathematical calculation using the Fourrier equations, or an instrument



	FREQ.	AMP.	ENERGY=N^2A^2
Fundamental = 1st Partial	100	32.0	104.0
2nd "	200	22.0	194.0
3rd "	300	13.0	152.0
4th "	400	7.0	78.5
5th "	500	3.5	30.6
6th "	600	3.0	32.4
7th "	700	2.0	19.5
8th "	800	4.0	102.0
9th "	900	2.0	32.0
10th "	1000	1.5	22.5
11th "	1100	1.0	12.1
12th "	1200	1.0	14.4

FIG. 9

The complex sound wave produced by a single organ pipe. Its harmonic analysis gave the table of simple tones which provides an accurate physical description of the sound itself. The wave was obtained by Professor Dayton C. Miller of Case School of Applied Science, Cleveland, with his "Phonodeik"

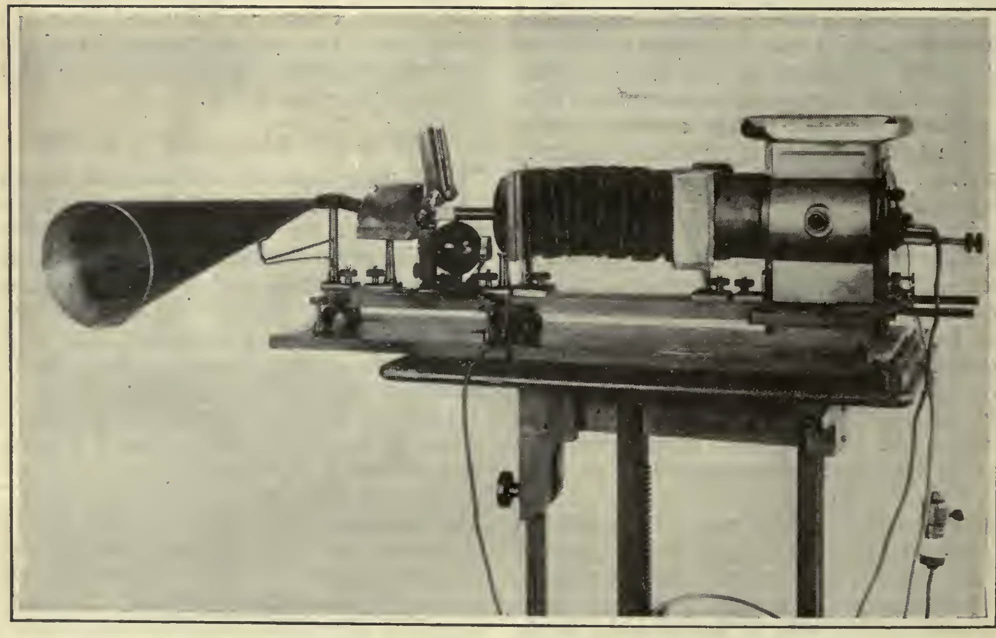


FIG. 10

Professor Miller's "Phonodeik" which records the wave form of sounds

known as the Harmonic Analyzer may be used (based on the same mathematical laws) which traces the curves of all the partial tones directly.

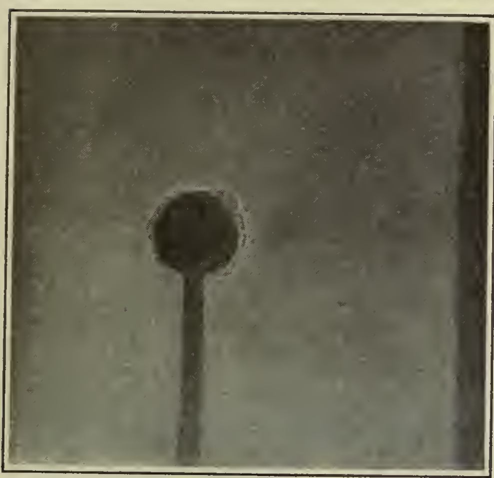


FIG. A

Through an error, the spark wave photographs published on page 1061 in Mr. Miessner's article, "The Physics of Sound" in Radio Broadcast for April were printed so as not to show the actual waves themselves. Figs. A, B and C, are reproductions showing the circular shadows of the spherical waves of condensation (dark), and rarefaction (light) produced by an electric spark behind the central black disc. This, Fig. A, shows a curved wave striking a soft felt pad without reflection. Here the wave in the felt is being absorbed and converted into heat

FIG. B

Here the large circle is the shadow of an expanding spherical wave. These photographs are presented through the courtesy of the Riverbank Laboratories, Geneva, Illinois

By means of such a process of recording and analysis, the mixture of simple tones in musical sounds can be determined just as the optician can determine with the spectroscope the various light frequencies present in any particular light emitted by a given light source.

Not only this, but even more remarkable things can be accomplished. With such an analysis of any given sound as is shown in Fig. 9, the physicist, like the artist who mixes numerous colors to produce the particular shade he desires, can synthetically produce the same kind of sound. To do this he produces simultaneously the component pure tones of correct frequency and amplitude, as determined by the analysis, using electrically vibrated tuning forks or stopped organ pipes. Almost any kind of musical sound can thus be imitated with practically perfect completeness.

FIG. C

The wave here shown is being reflected with reversed curvature from a hard, flat surface. It shows the reflection or "echoing" of a spark sound at the surface of a hard body. These photographs are very unusual ones, even though from a photographic point of view they may appear to be slightly hazy. The poor appearance of the negatives is due in no part to poor photographic technique, but it is wholly the result of the extreme difficulty of the subject

The modern pipe organ is one of the finest examples in which these principles are used. Dozens of different musical qualities or tone colors can be produced by control of the tone mixing stops on the manual. The "Telharmonium" and the "Choralcello," in which similar effects are produced by electrically vibrated sounding bodies, have wonderful possibilities in this direction, but have never attained commercial development.

The Better Receiver Contest

Additional Information About Our Search for an Improved Receiver for Home Construction—A Prize of $200 for the Design of a Better Set

AS EXPLAINED in the April magazine, RADIO BROADCAST, since its inception, has been endeavoring to present to its readers an abundance of up-to-the-minute radio information with special attention to exceptional receivers for home construction. Not content, however, with news alone, it has always been a policy that nothing be printed that was not an improvement over that which had gone before.

So it was that eventually the Roberts Knockout receiver was first presented to the radio field, and we have failed since that time to find a better circuit combining the various and singular attributes of this unusual set, although much effort and considerable money have been spent in this direction by the RADIO BROADCAST Laboratory. Members of our technical staff, combining a wealth of technical knowledge and experience, have been experimenting for the past eight months, but they confess that they are unable to improve the basic features of this receiver.

Now what we should like to know is, Where can a better receiver be found? We confess we are beaten, and we are ready to pass the buck. The responsibility naturally devolves upon those to whom the radio field, in the final analysis, owes most, to those experimenters and amateurs, engineers and what not, who have contributed development upon development, discovery upon discovery to the art of radio telegraphy and telephony.

WHERE CAN A BETTER RECEIVER BE FOUND?

DO YOU know of a better receiver? If you do write to us and tell us about it, or, better still, send us a set all hooked-up and we will test it in our Laboratory. If it is better than the Roberts we are willing to pay generously for an article completely describing it and if it meets with the approval of those selected to serve as judges in this contest, we will mail you a check, not for $100 as indicated in our April announcement, but for $200 which amount we consider more in keeping with the magnitude of the task which we have set before you.

We remain unconvinced. We don't believe that you can do it. Do you think you can? Then write to us and prove it!

The following specifications must be incorporated in the desired receiver:

1. The receiver must not radiate.
2. It may employ four tubes (or less if you think four are unnecessary).
3. It must be extremely selective.
4. It must be constructed to occupy a reasonably small amount of space.
5. It must be capable of operation with dry cell and storage battery tubes.
6. It must be capable of operation with tubes operated at their normal filament voltage.
7. It must be built to permit the transfer of tubes from one socket to another without materially changing the results obtained.
8. It must produce good quality, without blasting or rattling on a cone-type loud speaker.
9. It must be capable of satisfactory performance with several makes of parts designed for similar use.
10. It must not require critical grid condenser or grid-leak adjustment.
11. It must be simple to control.
12. It must permit the use of voltage up to 120 on the audio amplifier tubes (though less may be used if desired).
13. The plate current consumption of the four tubes (measured at normal filament voltage) must not exceed 10 milliamperes when storage battery tubes are used.
14. It must be capable of exceptional long-distance reception, with volume sufficient to fill a good-sized living room.
15. It must be simple to operate.
16. It must be free from hand capacity.
17. Shielding must not be used.
18. It must be capable of loud speaker operation on two tubes.

It will be noticed by comparing the above specifications with those contained in the April announcement that a few changes have been made. These changes have been considered necessary in view of the extreme difficulty of the task we have set before you, and they make the goal, on the whole, perhaps easier of attainment.

Three judges have been appointed to decide impartially which is the better receiver—yours or the Roberts. You will get a square deal at their hands.

The conditions of the tests which we will give your apparatus remain as indicated in the original announcement.

This offer is made, we repeat, only to those

who are interested in designing receivers for home construction. Later, if manufacturers of complete sets wish to employ a similar method of proving the excellence of their apparatus, we will have no objection, but in this particular contest only home built sets are concerned.

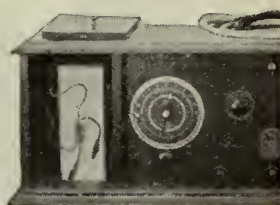
Most of the letters received thus far presenting us with descriptions of apparatus to be entered in this contest, have failed to comply with the conditions set forth above. We caution future participants that unless the rules governing this contest are adhered to, their communications will not receive our consideration. Many of our correspondents about this contest have failed to adhere to some one or more of the rules. The receiver to be entered must fit the specifications printed above. When you write us about your receiver, please condense your information as much as possible and take great care with the circuit diagrams.

Now we ask again, Have you a better receiver than we have discovered? We doubt it, but if you are sure you have, submit it to us and we will test it out.

FITTING THE RADIO TO THE RADIATOR

This photograph shows a receiver placed on a metal cabinet which fits over the radiator. Ordinarily, the radiator, especially in small homes and apartments is somewhat uneconomical, because the space it occupies cannot be used for anything else. The cabinet contains a humidor which moistens the air and the shelf is insulated which keeps it from absorbing heat. With this cabinet, made by the Dixie Metal Products Company at Birmingham, Alabama, the radiator is made to do double duty. The new Farrand-Godley loud speaker and Carter self-supporting loop are also shown

THE photograph in the lower left shows the receiver with the Lynch Lead ready to put in the automobile. The circle in the upper left shows how a potato can be used to determine the polarity of the battery leads. When the current is on and the bare wires applied to the potato, a green deposit forms around the negative wire which is then connected to the negative terminal of your receiver



Take Your Radio Set to the

WHEN your radio receiver goes on summer motor and camping ent to take along storage batteries to supply the filament vol of the automobile furnishes six volts which is the proper potential of the tubes. The photographs on these pages show how the Lynch H. Lynch, editor of this magazine, can be used for connecting the to the radio receiver. The Radiola super-heterodyne is supplied the illustrations show how Brightson True Blue Power Plus tubes tery filament and a small base can be substituted in the "super."

In the Radiola super-heterodyne, the dry cells which furnish considerably to the weight of the receiver. If the Lynch Lead is tomobile storage battery for the dry cells the decreased weight of more portable—an important consideration for summer radio.

Any radio receiver, including all those described in this magazine, can be operated in this way from the automobile battery. The shows Mr. Lynch operating super-heterodyne in his automobile. loud speaker in use.

THE upper cut shows John B. Brennan, Technical Editor of RADIO BROADCAST, substituting Brightson True Blue Tubes in the Radiola super-heterodyne so that it may be operated from the automobile storage battery. The center photograph shows the space left in the battery compartment of the "super" when the dry cell A batteries are removed

Country!

trips, it is often inconveni-
tage. The storage battery
for supplying the filaments
Lead, developed by Arthur
automobile storage battery
with three-volt tubes and
which have a storage bat-

the filament potential add
used, substituting the au-
the receiver makes it far

with the use of this cord,
photograph at the right
Note the small Amplion

Making Your Receiver a Super-Heterodyne

A Simple and Inexpensive Unit Which the Home Constructor Can Easily Build—It Can Be Applied to Any Type of Receiver

By A. O'CONNOR

ANY number of radio users have tried for a long time to find a simple method of converting their present receivers to super-heterodynes. Nothing short of complete rebuilding has been the solution in the past. Up to now, there has really been no satisfactory method. The frequency-changer circuit described by Mr. O'Connor in this article is really a "canned" super-heterodyne which can be applied to any kind of a receiver except a super-heterodyne itself.

Obviously there are two main avenues of endeavor which lead to the discoveries of real improvements in radio: those undertaken by commercial interests, and those in which the home experimenter plays the leading rôle. Radio Broadcast believes that it should present the best and most helpful material which may be developed by both types of radio investigators. We judge the material which is considered for the editorial pages of the magazine by one measure: Will it help the reader? The fact that Mr. O'Connor falls into the commercial rather than the private investigator class has not influenced our policy in publishing this interesting and helpful article.—The Editor

A SUPER-HETERODYNE of two tubes is not only possible but practical; any receiver now in operation may be made into a sensitive, selective super-heterodyne. With these two thoughts in mind, the writer began experiments over a year ago that brought the results outlined in this article describing a simple one-tube unit that will make a "super" out of any good receiver, be it simple or complicated.

Briefly, this unit changes incoming signals to a given frequency, just like the best of super-heterodynes, and the receiver that the listener now possesses acts as the "intermediate frequency amplifier" that is such an important part of present super-heterodynes. This unit is not difficult to construct, requires but little room, and uses standard parts that may be obtained generally.

Such a unit will allow hundreds of thousands of listeners to have the benefits of the "super" at small cost and without discarding their present receivers.

WHAT THE "SUPER" REALLY IS

TO UNDERSTAND just how such a simple super-heterodyne may be constructed it is necessary to delve a bit into the theory underlying this selective circuit. The "super" is really a frequency-changer, and this unit, described in Radio Broadcast for the first time is, simply, a frequency changer.

In super-heterodyne receivers incoming frequencies are changed to some lower frequency, after which they are amplified by "intermediate-frequency" amplifiers and then detected in the usual fashion. The lower frequency varies with different super-heterodynes, but usually is about 30,000 cycles (10,000 meters). There are reasons why this frequency

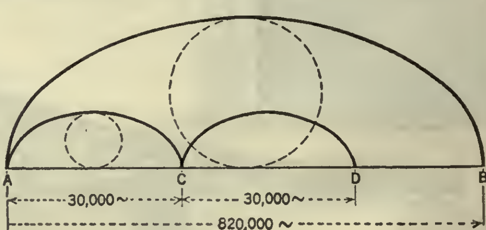


FIG. I

The broadcasting band of frequencies is 820,000 cycles wide and is represented here by taking a point on the circumference of a wheel and marking out its path as it rolls along the frequency line. At the end of one complete revolution the point has traversed 820,000 cycles. The smaller wheel representing the oscillator dial traces a similar path but in one revolution it traverses only 30,000 cycles. There are two points 60,000 cycles apart that a given station may be heard

may not be much lower, but few why it cannot be higher. and that is what is done in this unit where an intermediate frequency of about 500,000 cycles (600 meters) is used.

These lower frequencies are generated by a phenomenon called "beats" and are the result of compounding two waves of different frequency. As a concrete example, let us suppose the intermediate amplifiers are tuned to 30,000 cycles and an incoming signal has a frequency of 750,000 cycles (400 meters.) Within the receiver is a frequency generator which we may vary until the difference between its frequency and that of the incoming wave is 30,000 cycles. At this point the intermediate amplifiers work

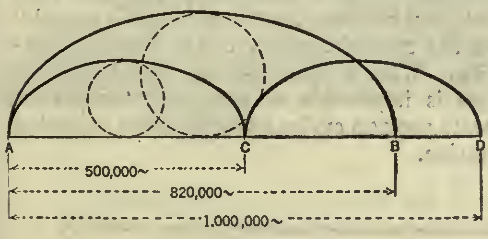


FIG. 2

By making the smaller wheel much larger, the path a given point on its circumference would trace out is longer. Before it completes two revolutions however, it is outside the broadcasting band, and for this reason there will be only one point on the oscillator dial where a given station will be heard

best and the signal will be passed along to the detector.

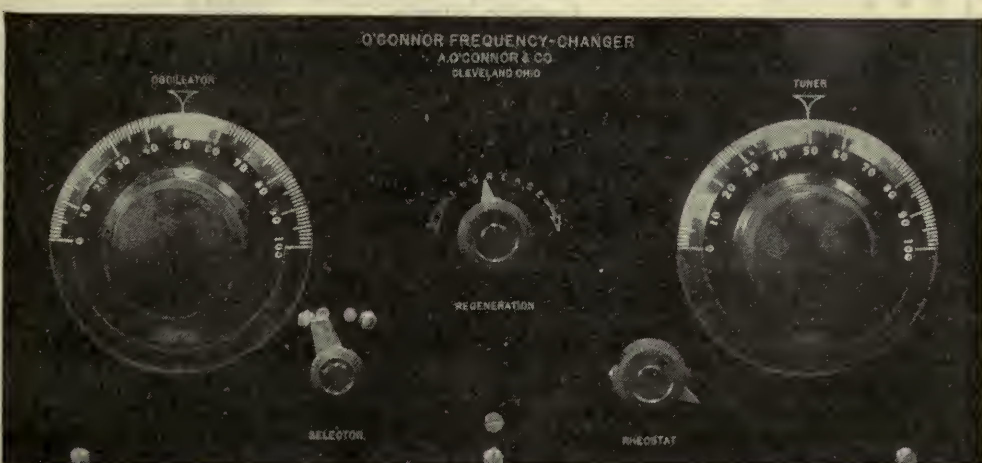
This lower frequency may be obtained, in general, at two adjustments of the oscillator dial, namely, at the 750,000 plus 30,000 or 780,000 cycles and 750,000 minus 30,000 or 720,000 cycles. These two points correspond to 417 and 385 meters.

Thirty thousand cycles is such a small percentage of the broadcasting frequencies that the two points on the oscillator dial are always close to the value of the incoming frequency, although on the longer waves the two points are farther apart on the dial than at the low wavelength end of the dial.

These two points are 60,000 cycles apart, and the action of tuning a given station at two points within the broadcasting band is something like a small wheel revolving within a large one as shown in Fig. 1. The small wheel may begin to rotate at any point, but at the end of two complete revolutions the same broadcasting station may be heard again. And since the present broadcasting band covers 820,000 cycles, it is apparent that there will always be two points on the oscillator dial for each incoming frequency—if the intermediate amplifiers are tuned to 30,000 cycles.

Suppose, however, that the intermediate amplifiers are tuned to 500,000 cycles. In this case, the same station will be found at two points 1,000,000 cycles apart, and since the broadcasting band is only 820,000 cycles wide, we may plan our coils and condensers so that the incoming frequency will be heterodyned at only one point on the oscillator dial.

All we have to do now is to design an oscillator that will beat at frequencies 500,000 cycles different from incoming frequencies. At the lower end of the broadcast wavelength band, 220 meters equals 1,363,636 cycles and at the



RADIO BROADCAST Photograph

FIG. 3

The panel view of the frequency changer. Simplicity and symmetry are the keynotes of construction and layout. Due to the engraved indicators, the functions of the various control dials are self explanatory

other end of the broadcasting band, 550 meters corresponds to 545,454 cycles. To find the frequency of the oscillator to give us the required 500,000-cycle beat note, we must add to or subtract 500,000 cycles from these two extreme frequencies. Thus,

220 meters = 1,363,636 cycles plus 500,000 cycles = 1,863,636
220 meters = 1,363,636 cycles minus 500,000 cycles = 863,363
550 meters = 545,454 cycles plus 500,000 cycles = 1,045,454
550 meters = 545,454 cycles minus 500,000 cycles = 45,454

Therefore an oscillator of the range 1,863,636 to 1,045,454 or an oscillator of the range of 863,363 to 45,454 cycles would give the required beat frequency. These two oscillators would cover wavelengths from 161 to 287 meters or 348 to 6600 meters. Obviously the first one is the proper one to use.

In this case there will be only one point in the oscillator dial where a given station may be found as shown in Fig. 2.

There is still another advantage in heterodyning to 500,000 cycles. When heterodyning to 30,000 cycles, it is quite often the case that the lower one of the two points for station No. 1 is in exactly the same spot as the upper point of station No. 2 which is on a shorter wavelength. This causes heterodyning with the attendant howls and moans. Sometimes the upper point of station No. 1 interferes with the lower point of station No. 3 which is on a longer wavelength; again we have heterodyning with the resultant discordance, and we find that we are unable to get station No. 1 clearly on either of its two points. Such a condition is impossible with 500,000 cycle beat frequencies, as it is impossible to get a station at more than one point on the oscillator dial.

With most "supers," the oscillator is continually making an audible heterodyne with the incoming station as the dial is turned between the two points for the incoming station. This is because of the fact that half way between the two points it is actually on the exact frequency of the incoming station. With a 500,000-cycle beat frequency this is impossible as the oscillator always beats 500,000 cycles away from the incoming station.

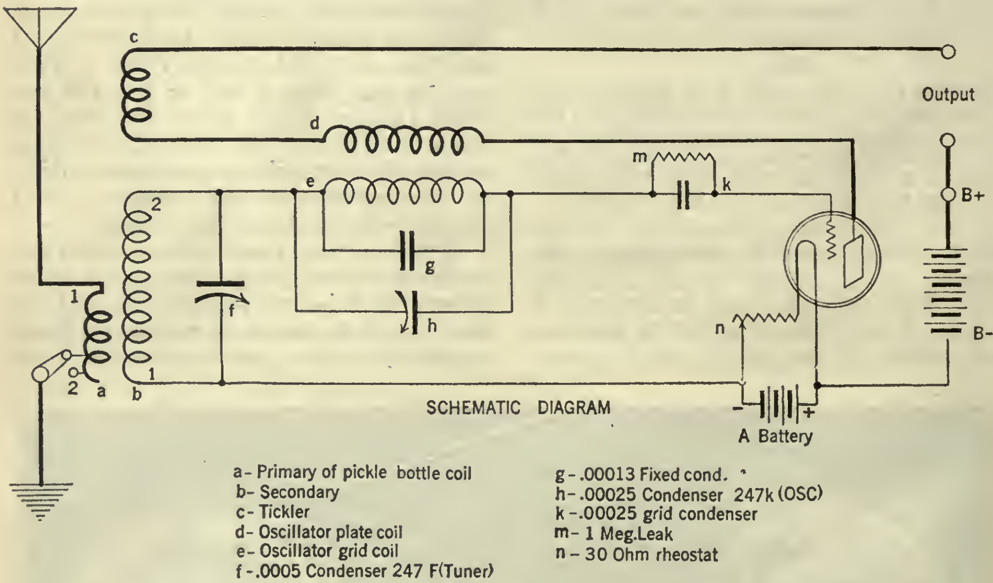
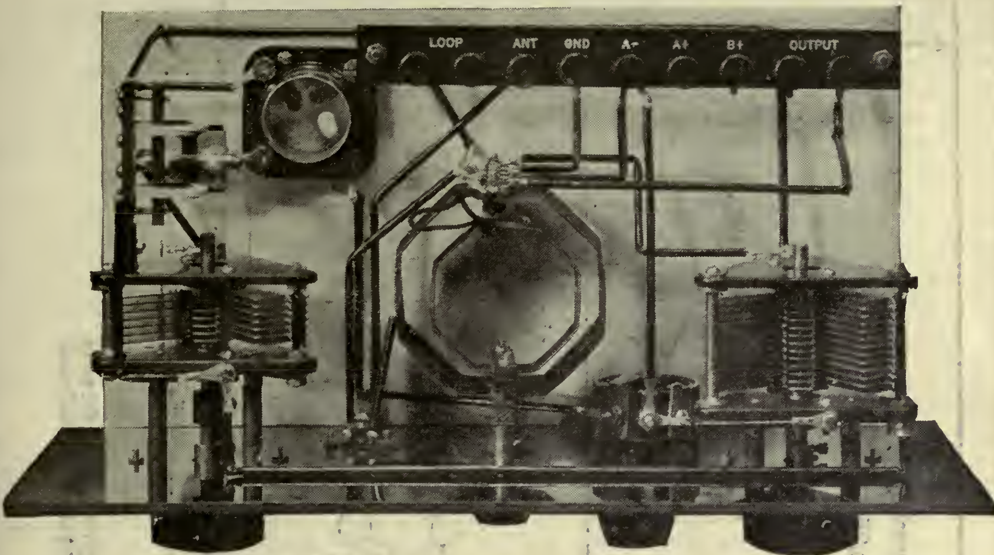


FIG. 4
The schematic diagram of the frequency changer showing the Armstrong system of securing local oscillations in the first detector tube

HOW YOUR PRESENT RECEIVER IS USED

NOW that we have the 500,000-cycle beat note generated in our frequency-changer, it remains to provide an intermediate amplifier tuned to this frequency, and here is where our receiver now in operation comes in. All that is necessary is to tune it to 600 meters (500,000 cycles) and to place



RADIO BROADCAST Photograph

FIG. 5

Looking down on the layout one clearly sees the general disposition of parts and the wiring scheme. The frequency-changer is really a very simple unit as this photograph shows

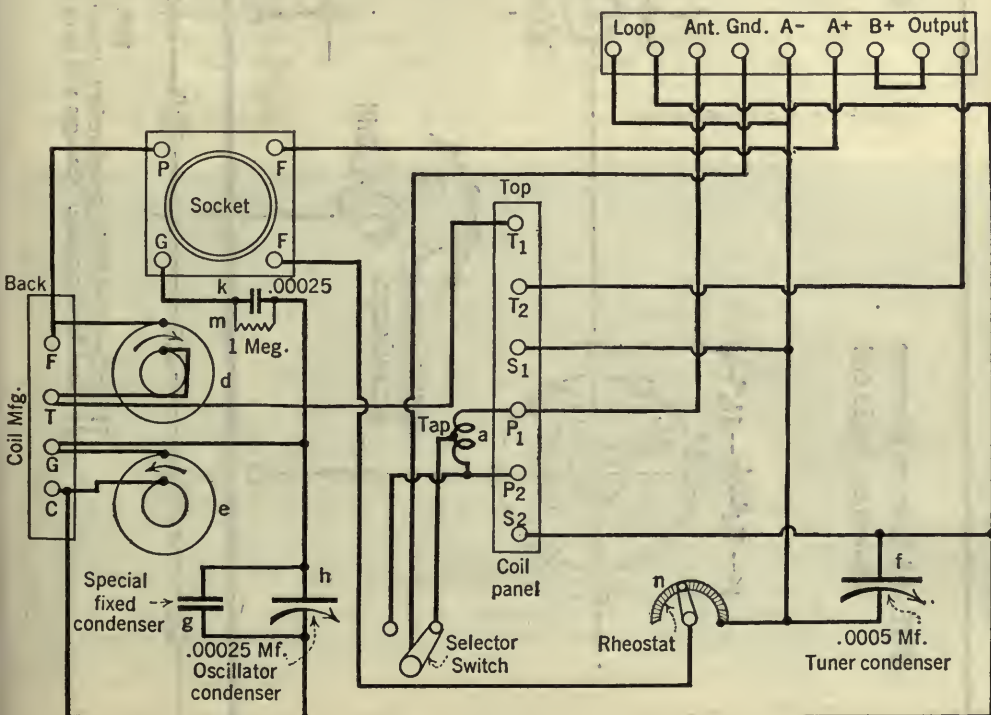


FIG. 6

The wiring diagram of the one tube super-heterodyne showing the connections of the various units

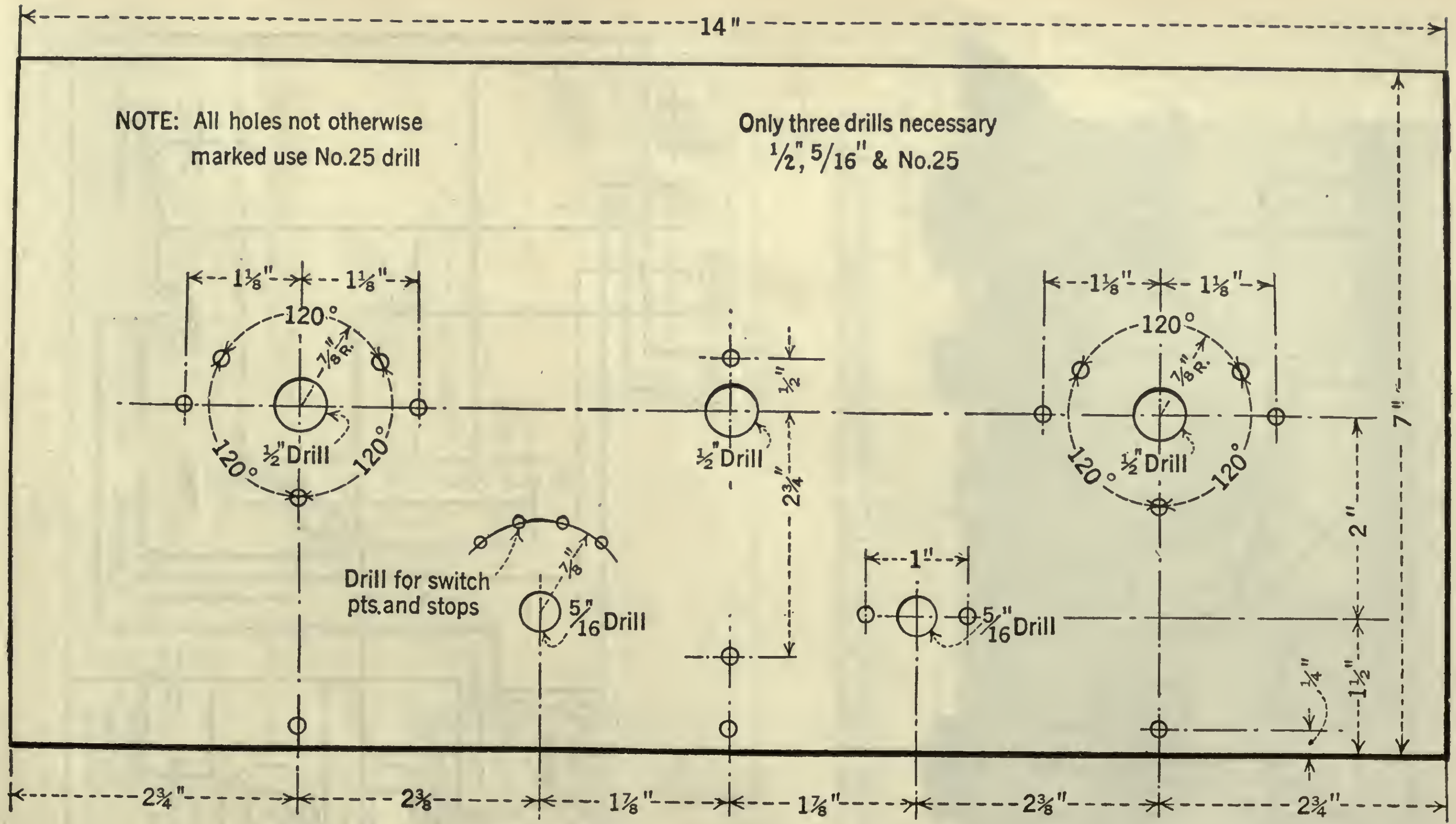


FIG. 7
This is the actual drilling template for the panel, and the dimensions given apply to the parts described in this article. Changes will have to be made if other parts are substituted

its antenna and ground connection to the output of the frequency-changer, and we have a super-heterodyne.

Fig. 4 shows the schematic diagram of the circuit and Fig. 6 shows the connection hookup. In Fig. 6, coils A, B, and C are the three windings of a three-circuit tuner, the primary (A) being untuned. Incoming stations are tuned by the condenser F across the primary coil B. Their frequencies are heterodyned to 500,000 cycles by oscillator coils D and E, the latter coil being tuned by condenser G and H. Condenser G is placed in the circuit to increase the spread of the stations on the oscillator dial. The plate circuit, before it is introduced into the next tuning circuit, is brought into inductive relation with the secondary tuning coil B, thus causing regeneration and increasing both volume and selectivity. The plate circuit now contains, among other frequencies, the desired frequency of 500,000 cycles, and is introduced into the receiving system, where it is tuned and rectified in the same way that a 600-meter station can be tuned in.

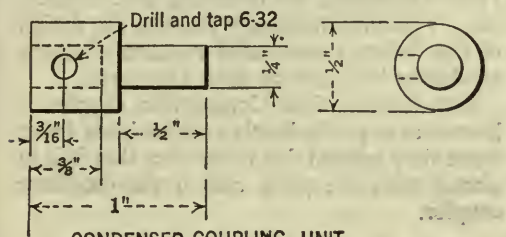
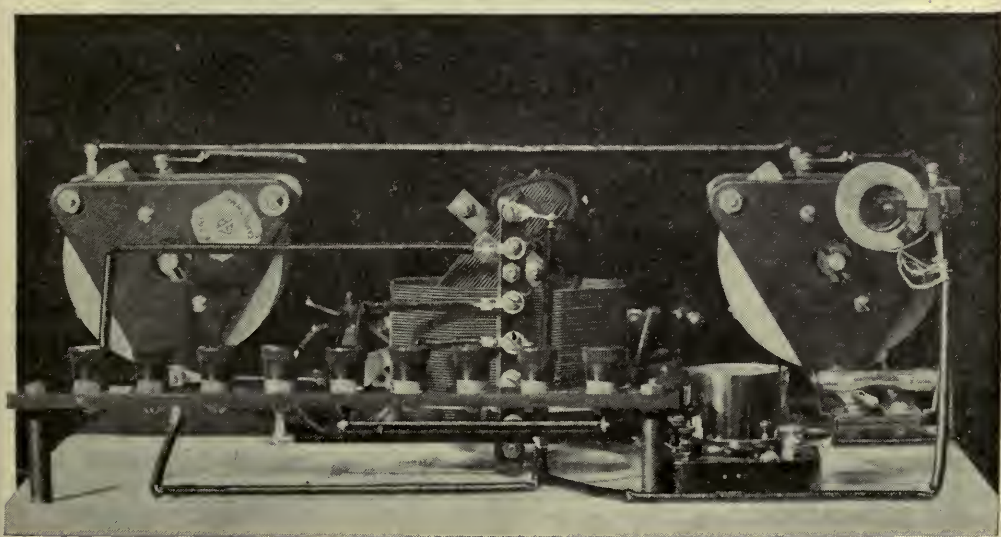


FIG. 8

To shield the condenser from body capacity effects it should be placed some distance from the panel and this coupling member enables the proper spacing to be carried out

You will note that in this arrangement, one tube receives and heterodynes at the same time. Up until a year ago this was not considered feasible, because tuning the oscillator circuit would detune the antenna circuit, due to the two frequencies being so close together. Major Armstrong showed that it is possible, if the frequencies are quite a distance apart, and exhibited an ingenious scheme for using one tube while maintaining a low frequency intermediate wave. In the frequency-changer which we are describing, the two circuits are always 500,000 cycles apart and tuning one circuit has no effect on the other. In constructing the frequency-changer, the idea of low loss has been kept constantly in mind, and, by direct comparison, low loss parts gave the best results. Distributed capacity in coils was hunted down, and condensers of the highest type were used, the oscillator condenser being insulated from the hand by means of a good dielectric. The parts used are listed below, but of course equivalent parts can be used, always providing that the constants are correct.



Radio Broadcast Photograph

FIG. 9

This rear view shows clearly the disposition of the coils and other apparatus. Note how the oscillator coils are clamped between the two bakelite strips which are fastened to the oscillator condenser

ITEM	
1	1 Formica panel 7 x 14 x $\frac{3}{16}$ inches
2	1 Baseboard 12 $\frac{3}{4}$ x 7 x $\frac{1}{2}$ inches Poplar
3	2 National Velvet Vernier 4-inch Dials
4	1 General Radio Switch Lever $\frac{7}{8}$-inch with two Contact Points and two stops
5	1 General Radio No. 301 Knob and Pointer; for use on the tickler coil.
6	1 General Radio No. 301 Rheostat 30-ohm.
7	1 General Radio No. 247 F Condenser .00025 mfd. logarithmic plates.
8	3 $\frac{1}{2}$-inch Lengths Formica Tubing $\frac{5}{16}$ inch o. d. $\frac{3}{16}$ inch i. d. to space Item 7 from panel
9	1 Formica Coupling Member for Item 7 (Fig. 6)
10	1 General Radio 247F Condenser .0005 mfd. logarithmic plates
11	3 $\frac{1}{2}$ inch Lengths Formica Tube $\frac{5}{16}$ inch o. d. $\frac{3}{16}$ inch i. d.
12	1 Eastern Coil Corporation Coupler, Broadcast Wavelength, (15 turns on tickler, with middle tap on primary)
13	1 King Socket R730 for UV-201-A Tube
14	1 Dubilier Grid Condenser .00025 mfd. Type 601-G.
15	1 Daven Grid Leak .1 megohm
16	1 Binding Post Panel complete with 9 binding posts
17	1 Oscillator Coupler as per Fig. 7; coupler includes two coils as per description later in this article.
18	Screws, wire, spaghetti, terminal lugs, etc.

Total cost of the above parts should be between \$35.00 and \$40.00.

Fig. 7 shows the actual drilling template for the panel, but of course changes must be made if other material is used.

Fig. 8 shows a coupling member for the .00025-mfd. variable condenser. This insulates the condenser from body capacity. Item No. 3 in the list above covers three Formica tubes which are used to set the oscillator condenser back from the panel, and to line it up with the other condenser. Item 11 covers spacers for the .0005 mfd. condenser. These are necessary because the design of the Velvet Vernier dial requires that the condenser be set back from the panel.

The Eastern Coil Corporation coupler is known as a pickle-bottle coil, and has fewer turns than normal due to the fact that it is in circuit with the plate coil of the oscillator coupler.

THE UNUSUAL OSCILLATOR COUPLER

FIG. 10 shows the details of the oscillator coupler. This coupler is not the conventional type at all. In the usual coupler, the coupling between the plate and grid coils is fixed, and the coils are so large that their external fields exert an influence on all parts within a range of several inches. An attempt was made in this frequency-changer to design an oscillator which would have no effect on other parts, and this result was finally achieved. The coils shown have an exceptionally small external field, and the grid coil is placed $1\frac{1}{4}$ inches back of the oscillator variable condenser, a position in which it has no effect on the condenser. The coils are known as "cross-wound," and have about as little distributed capacity as any coil known. The coils are wound on a $\frac{5}{8}$-inch core, are $\frac{1}{8}$ inch thick, and each has 49 turns

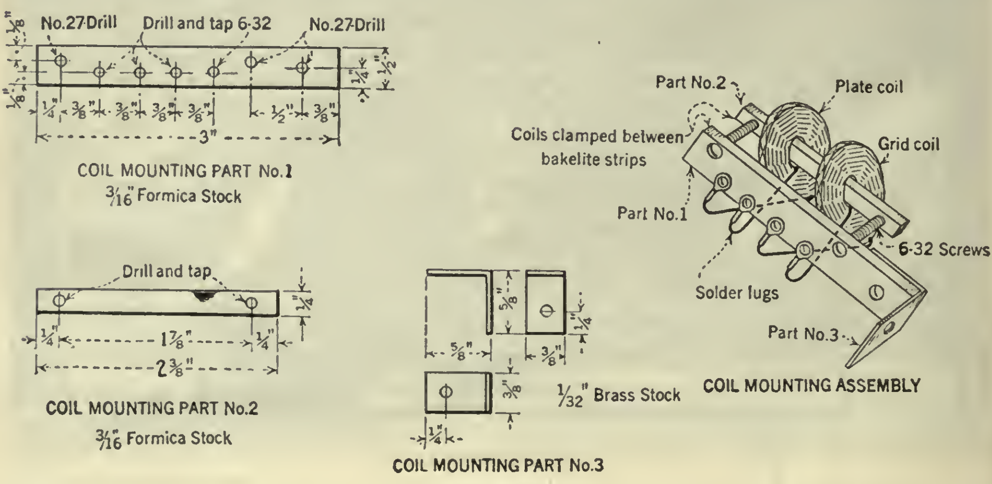


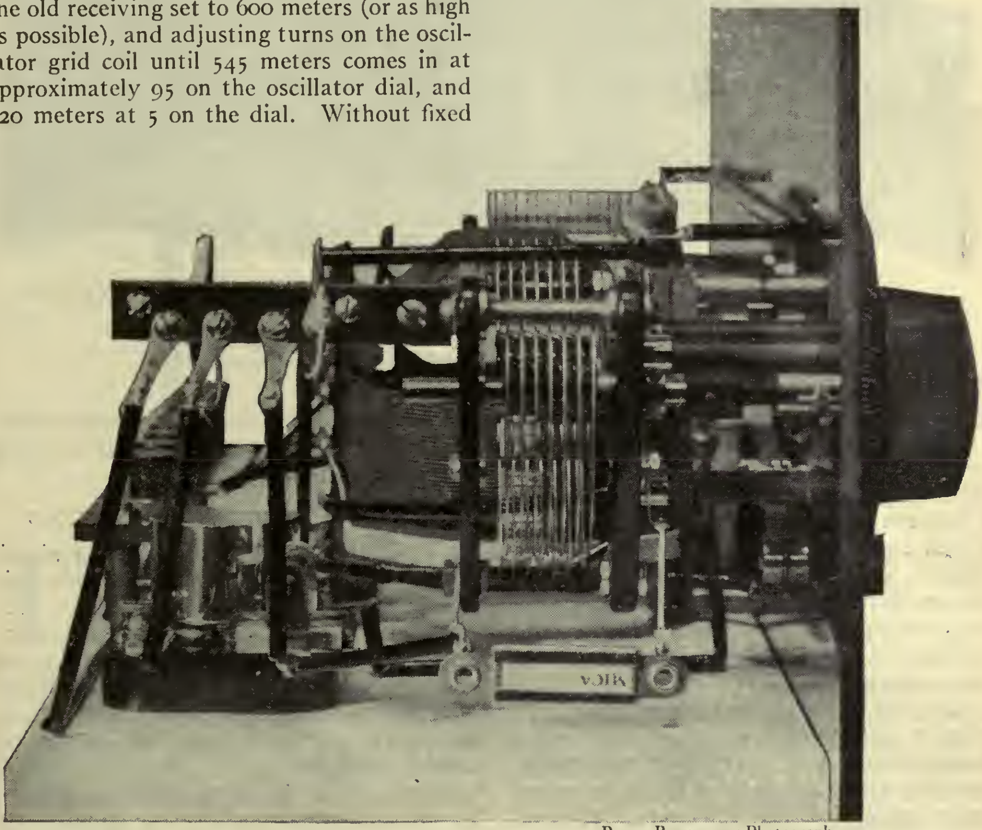
FIG. 10

The details of the oscillator coupler are shown in this Figure. Small coils placed at some distance from their tuning condensers decrease the external field and the resultant coupling effects to other parts of the circuit

of No. 24 double cotton covered wire. Experimenters who desire to wind their oscillator coils, and are unable to make cross-wound coils, can use Lorenz (basket-weave) such as made by the Perfection Coil Co. or Sickles (diamond-weave) coils, and attain the same results, although the coils should be set back some distance from the oscillator variable condenser. By a cut-and-try method, the right number of turns can be ascertained, the calibration being determined by changing the old receiving set to 600 meters (or as high as possible), and adjusting turns on the oscillator grid coil until 545 meters comes in at approximately 95 on the oscillator dial, and 220 meters at 5 on the dial. Without fixed condenser G of Fig. 4 it would be impossible to obtain this spread on the dial and the capacity of this condenser will have to be determined by trial. The value used in the frequency-changer shown in the photograph was .00013 mfd.

As mentioned above, in the usual oscillator coupler the coupling between plate and grid coils is fixed. Yet the best value of coupling varies with the frequency, and experiments have shown that most couplers have a value of coupling that is good for some frequencies and poor for others.

The best value of coupling for a given frequency is minimum coupling; in other words, the coupling should be decreased until the point is reached where the tube is just ready to stop oscillating. By finding this coupling distance for all frequencies, a point can be determined that will give the best average coupling for all frequencies. In the coupler shown in Fig. 10 this point is determined by test, and the coil locked in place.



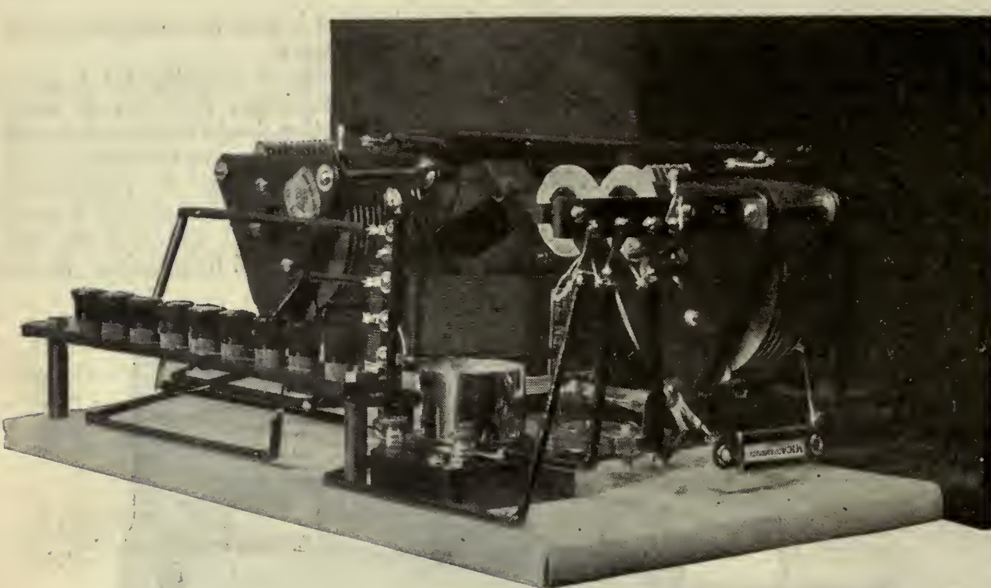
Radio Broadcast Photograph

FIG. 11

End view showing the method of placing the condenser some distance behind the panel to lessen body capacity effects. The separation of the coupling coils is clearly shown here

HOW TO PUT THE "SUPER" TOGETHER

MOUNT all apparatus on panel and baseboard, assemble the oscillator coupler on rear of .00025 mfd. condenser, or some distance back of the condenser if other than cross-wound coils are used. Connect the parts as per connection diagram Fig. 10, soldering wires to the terminal lugs instead of



RADIO BROADCAST Photograph

FIG. 12

A perspective of the completed frequency changer. The grid leak and condenser are supported by the tube socket and the wiring to it

wrapping them around screws. Connections to S1 and S2 on the pickle-bottle coil should preferably be of flexible wire, as these two wires must be disconnected if a loop is to be used. A loop can be used when this unit is to be attached to a multi-tube set such as a neutrodyne, or tuned radio frequency set. If the unit is to be used with a single-circuit or three-circuit regenerative set, a loop can be used if maximum selectivity and a range of 100 to 200 miles is all that is desired.

After all internal connections are made, connect the battery terminals to the same battery terminals on your present set, making sure that positive B on the frequency-changer has a value of at least 45 volts. You will notice that there is no minus B on the frequency-changer. This is because this connection is taken care of in your present set. Connect the antenna and ground to the frequency-changer instead of to your present set. If you have a five- or six-tube radio frequency set, you may use a loop instead of the antenna and ground by disconnecting S1 and S2 of Fig. 2 from the secondary winding of the pickle-bottle coupler. Now tune your receiving set to 600 meters, get maximum regeneration, and leave your dials set. All tuning is now taken care of by the two dials on the frequency-changer panel and regeneration can be obtained by rotating the pickle bottle tickler.

CARE MUST BE USED IN CONNECTIONS

BE VERY careful to examine *the circuit in your set* to which the output circuit of the frequency-changer is connected. This circuit *must not* be connected to the A battery circuit, or else there will be a short-circuit across 45 volts of the B battery. In some regenerative sets, and in neutrodynes, the A battery is grounded and this connection must be broken.

In an article to follow we will show a number of single-tube regenerative circuits and discuss the connections to, and operation of, the frequency-changer. We will also show how it is possible to "tune-in by the squeal" without annoying your neighbors. We will show the frequency-changer connected to a neutrodyne circuit and illustrate how to operate it on an antenna or on a loop. Best of all will be a method of connecting a frequency-changer to a crystal set, giving the long distance range of a single tube set with the selectivity equal to the finest super-heterodyne circuit. This makes a one tube circuit with the finest selectivity known.

Radio Broadcast's Phonograph Receiver

An Entirely New Method of Building the Four-Tube Knock-out Receiver to Fit in Any Phonograph—A Design Which Sets A New Mark for Home-Built Receivers

By ARTHUR H. LYNCH

THE most popular phonograph to-day is the phonograph in which radio is an integral part. It is possible to double the use and value of the many thousands of phonographs in this country to make them better instruments for the home by using some sort of radio receiver in connection with them. For some months, it has been possible to buy factory-made radio receivers which could be fitted into a compartment of the phonograph. But the home constructor has had to worry along as best he could.

Radio Broadcast has determined to experiment with the idea of furnishing the best design possible for home constructed receivers in the phonograph. We are gambling on our conviction that the home constructor, that everyone, in fact, is interested in making the phonograph a more valuable bit of domestic equipment. To that end, we have spent a great deal of time and money in canvassing the entire situation and we shall bring to you every month, for some time to come, the results of our findings. Those findings, we think, involve some distinctly new ideas in radio construction. We shall offer you an opportunity to build various models of one of the most compact and efficient radio receivers for home construction that we have ever seen.

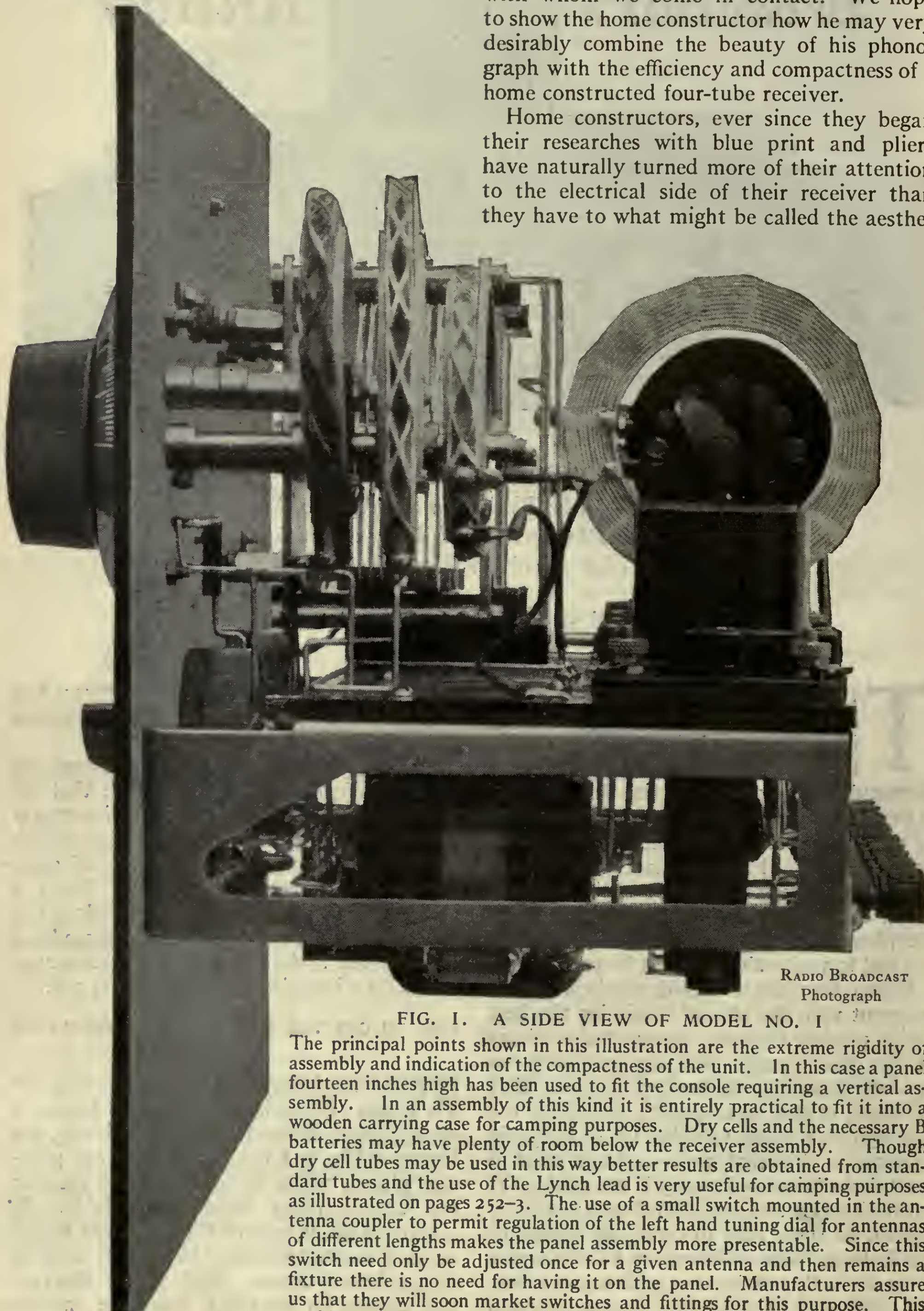
The phonograph is a very satisfactory means of entertainment, and we feel sure that by the proper design of a receiver for incorporation in practically any model of phonograph we are going to present something of great use to a large number of people. Many a perfectly good phonograph has been done out of a home by the radio set. Many more have been pushed aside, and their sole present use is to hold a beautiful lamp or a flower pot.

HOW TO GET THE MOST RADIO IN THE LEAST SPACE

RADIO has brought a new problem into the home. Space in many modern homes is often scarce. When the piano, the books, the library table, and the phonograph are properly placed, where to put the radio receiver has caused many brows to wrinkle. If a phonograph is part of the household equipment, it is often necessary to relegate it to an inconspicuous corner. And, if our observation counts for anything, there are entirely

too many phonographs that are now gathering whatever dust the housewife will permit it to collect. Too many phonographs are not used from one end of the year to the other. This has been the case in the homes of a number of our staff and in the homes of many people with whom we come in contact. We hope to show the home constructor how he may very desirably combine the beauty of his phonograph with the efficiency and compactness of a home constructed four-tube receiver.

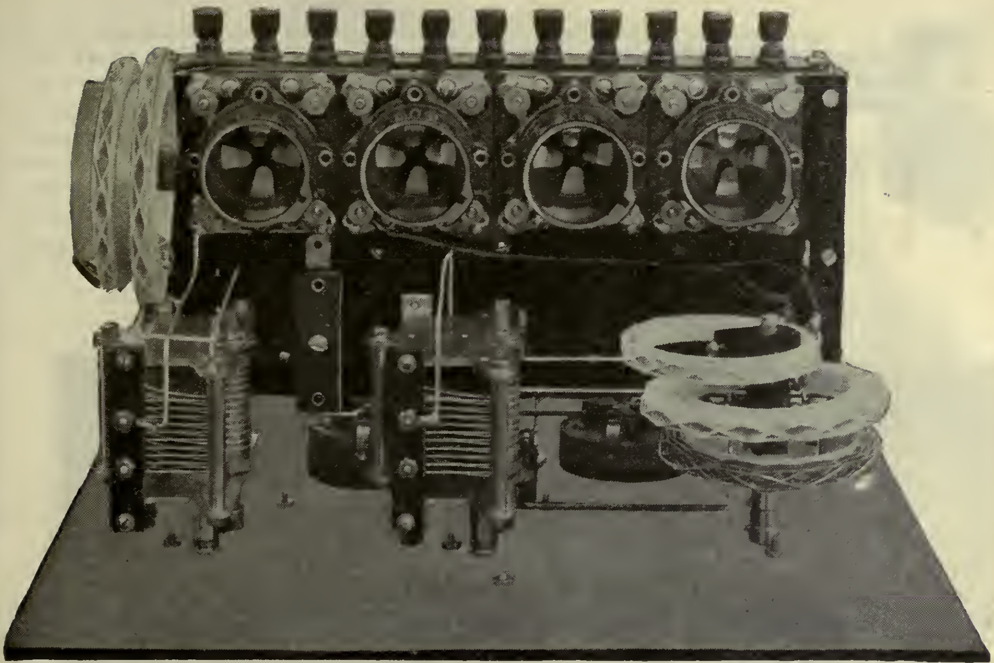
Home constructors, ever since they began their researches with blue print and pliers have naturally turned more of their attention to the electrical side of their receiver than they have to what might be called the aesthe-



RADIO BROADCAST Photograph

FIG. I. A SIDE VIEW OF MODEL NO. I

The principal points shown in this illustration are the extreme rigidity of assembly and indication of the compactness of the unit. In this case a panel fourteen inches high has been used to fit the console requiring a vertical assembly. In an assembly of this kind it is entirely practical to fit it into a wooden carrying case for camping purposes. Dry cells and the necessary B batteries may have plenty of room below the receiver assembly. Though dry cell tubes may be used in this way better results are obtained from standard tubes and the use of the Lynch lead is very useful for camping purposes as illustrated on pages 252–3. The use of a small switch mounted in the antenna coupler to permit regulation of the left hand tuning dial for antennas of different lengths makes the panel assembly more presentable. Since this switch need only be adjusted once for a given antenna and then remains a fixture there is no need for having it on the panel. Manufacturers assure us that they will soon market switches and fittings for this purpose. This idea was suggested to us by P. R. Morrison of Freeport, Long Island



RADIO BROADCAST Photograph

FIG. 2. TOP VIEW OF THE PHONOGRAPH UNIT

Particular attention is called to the assembly of the sub-panel as well as the position of the tube sockets. In order to permit the complete unit to be used in either a vertical or horizontal position without requiring a single change in construction and to offset the possibility of the tube filaments sagging and touching the grids, the correct placing of the sockets is important. Manufacturers who are to market a four-tube sub-base of this type at our suggestion have agreed to see that their products incorporate this attractive and important feature. Even though this receiver is very compact it will be observed that there is no crowding

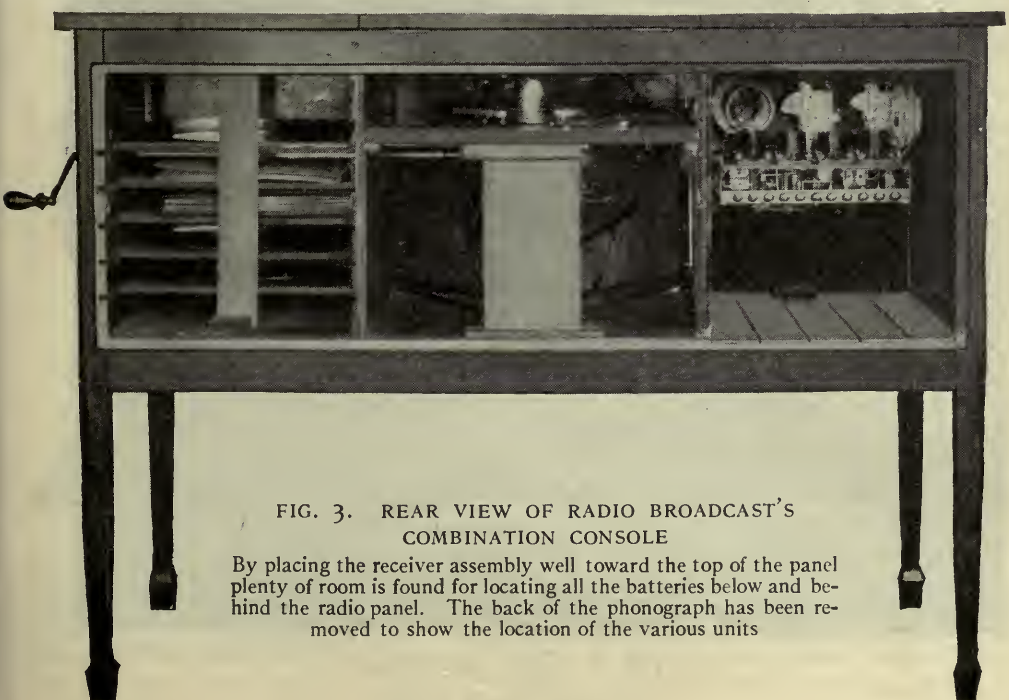


FIG. 3. REAR VIEW OF RADIO BROADCAST'S COMBINATION CONSOLE

By placing the receiver assembly well toward the top of the panel plenty of room is found for locating all the batteries below and behind the radio panel. The back of the phonograph has been removed to show the location of the various units

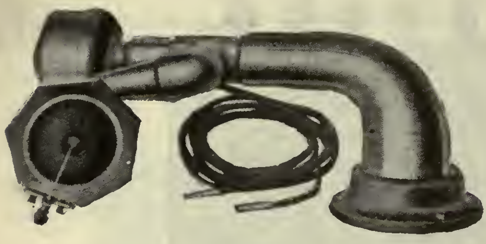
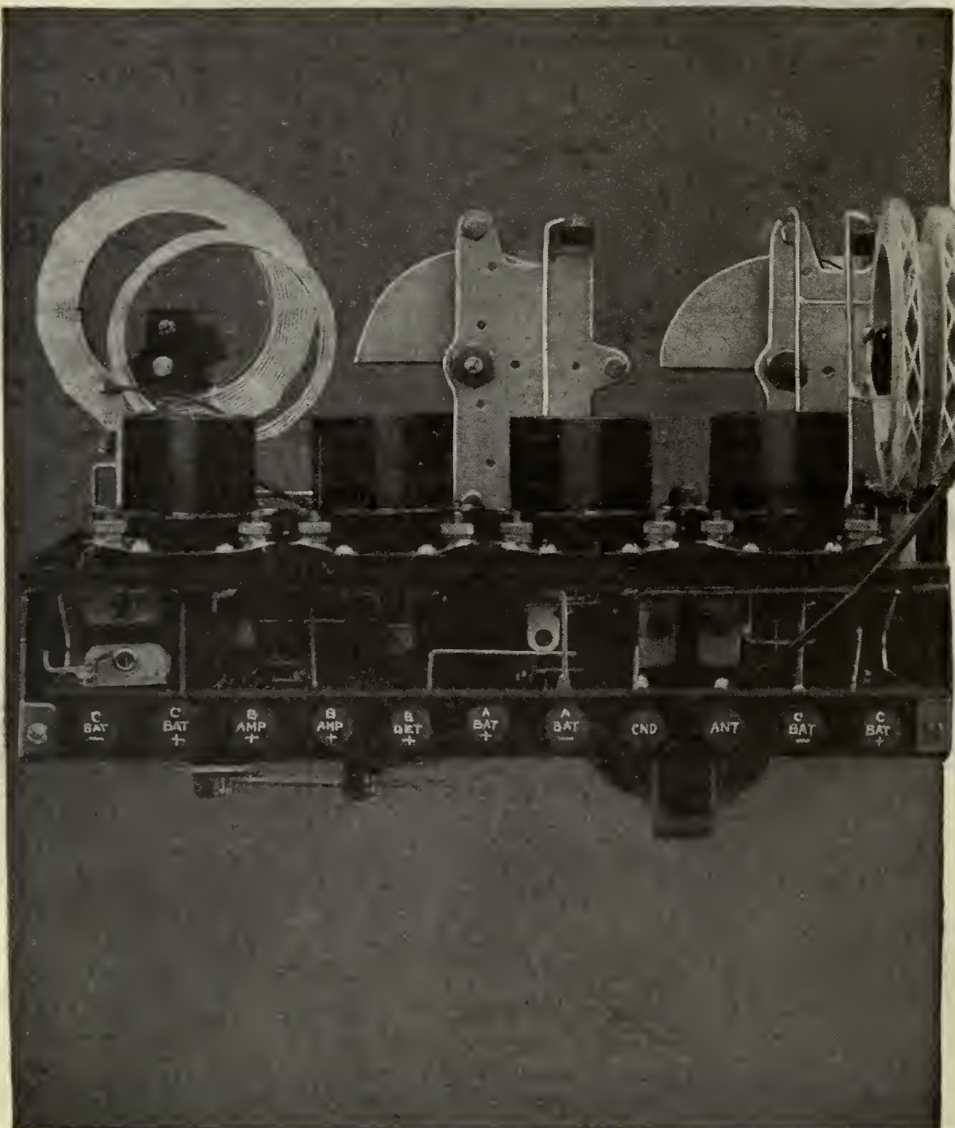


FIG. 4
A loud speaker and phonograph tone-arm now available commercially

tic side. If the set was put together and it worked, the cabinet in which the set was contained was often a secondary consideration.

Radio Broadcast's Phonograph Receivers will allow the constructor to utilize the handsome qualities of his phonograph cabinet, and the excellent sound chamber of that instrument. For these two reasons alone, we believe that many, many phonographs are going to come out of the shadow, not only to be seen but to be used again.



Radio Broadcast Photograph

FIG. 6. FROM THE REAR
This is how the unit appears

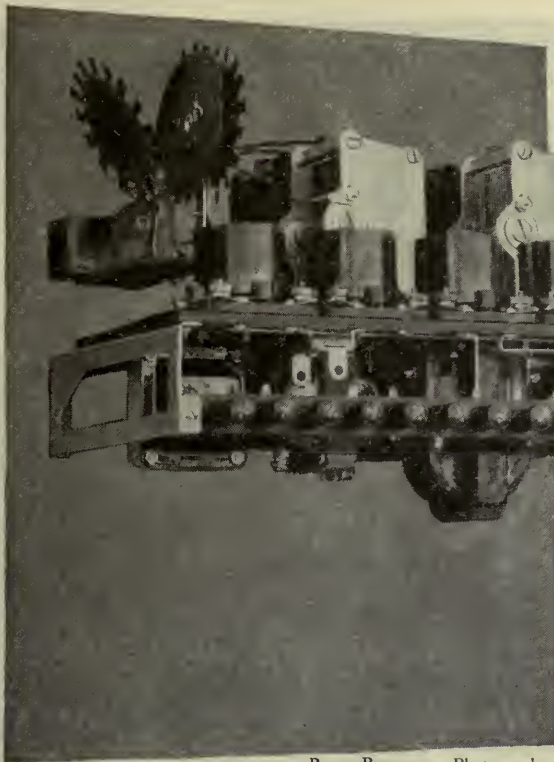
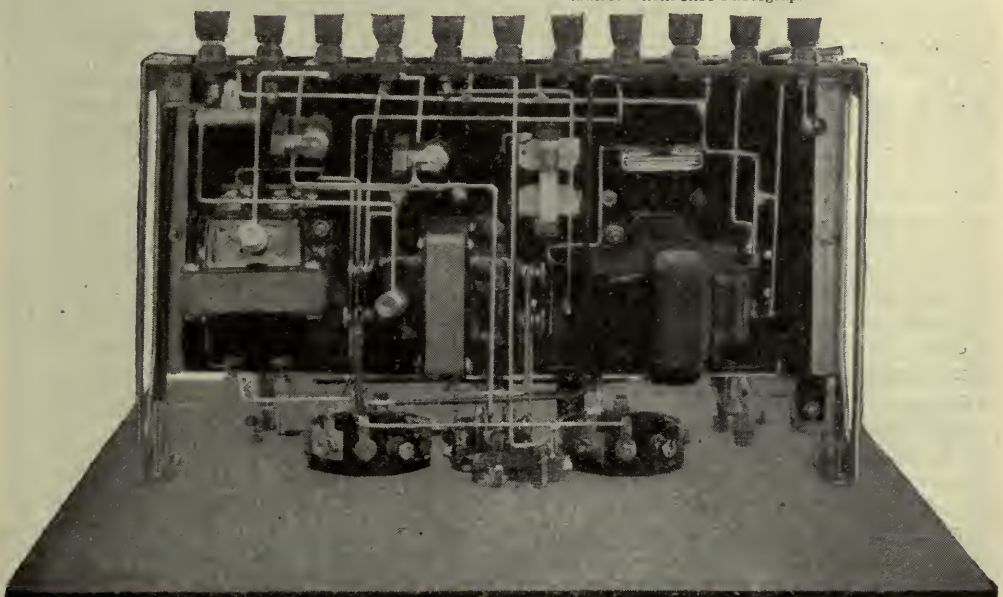


FIG. 6A. ANOTHER REAR VIEW

Showing how other coils and condensers may be employed without any change in layout

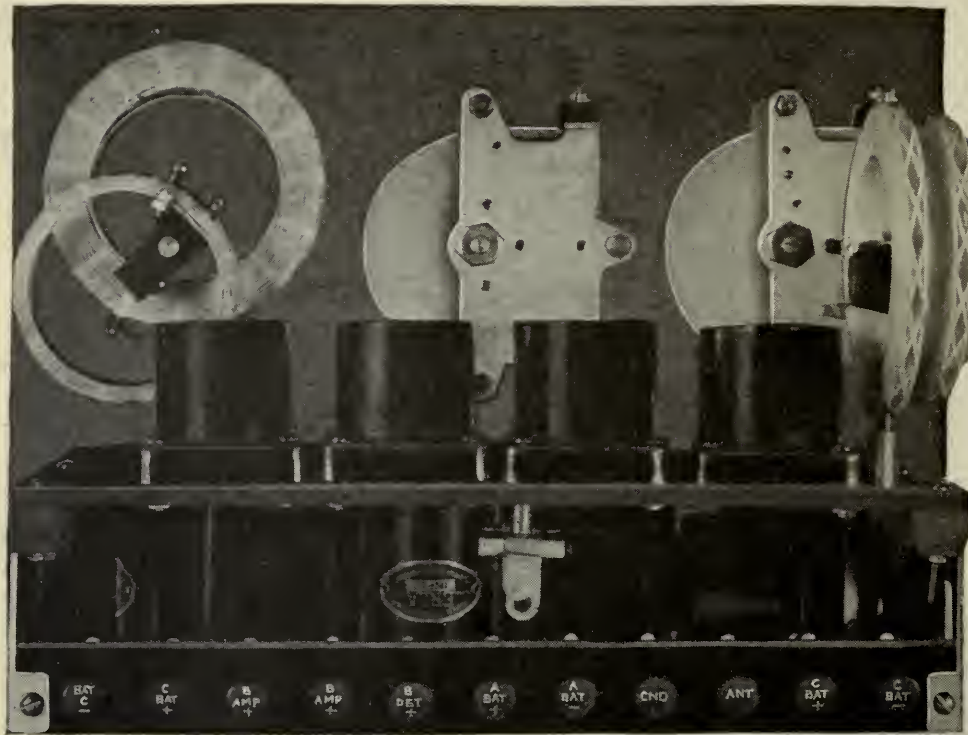
.Radio Broadcast Photograph



Radio Broadcast Photograph

FIG. 7. FROM THE BOTTOM

We get some idea of the wiring. In this unit we have used audio transformers of rather large physical dimensions in order to be sure that practically any transformers may be used without undue crowding. Amperites are used in the filament circuits of the push-pull tubes to reduce the number of manual controls as in Fig. 12. In receivers designed for use with UV–199 or similar tubes for operation from flashlight or dry batteries it is sometimes advisable to use a single rheostat for the two tubes as shown diagrammatically in Fig. 11



RADIO BROADCAST Photograph

FIG. 8. ANOTHER SAMPLE

In this arrangement another group of audio transformers are used and the spring sockets have been replaced by the rigid type. In order to cushion the tubes two strips of sponge rubber are placed between the sub-panel and its supporting brackets. In this receiver, flexible wiring is used and a series of wires with special colored covering as described in the article on standardization in the April RADIO BROADCAST is suggested. It is not a difficult matter to arrange color combinations within the receiver just as standards have been suggested for the wiring outside the receiver. It is not unlikely that design of this nature will soon find its way into receivers other than those for home construction. Wire manufacturers assure us they will soon be ready to supply such wire. It is well to compare this unit with Fig. 6. There was no noticeable difference in performance. Convenience for your particular assembly problem is the factor to decide upon between the two

If you use this combined radio-phonograph unit, there is no reason why you should ever be deprived of the very best in the world's entertainment. When the radio programs do not suit your mood, there is certain to be a record among your collection which will suit the occasion. The radio receiver and the phonograph have taken a tremendously important place in the home, and RADIO BROADCAST believes that both should be used to their fullest capabilities.

A radio receiver for a phonograph has to be designed so that it will fit the various cabinets in which it might be installed. The RADIO BROADCAST Phonograph Receiver consists of an extremely compact unit employing the excellent circuit developed for us by Walter Van Braam Roberts of Princeton University. The unit itself is so designed that it can be adapted to a panel of any size. The dimensions of the panel conform to the size of the phonograph cabinet into which the receiver is to be put.

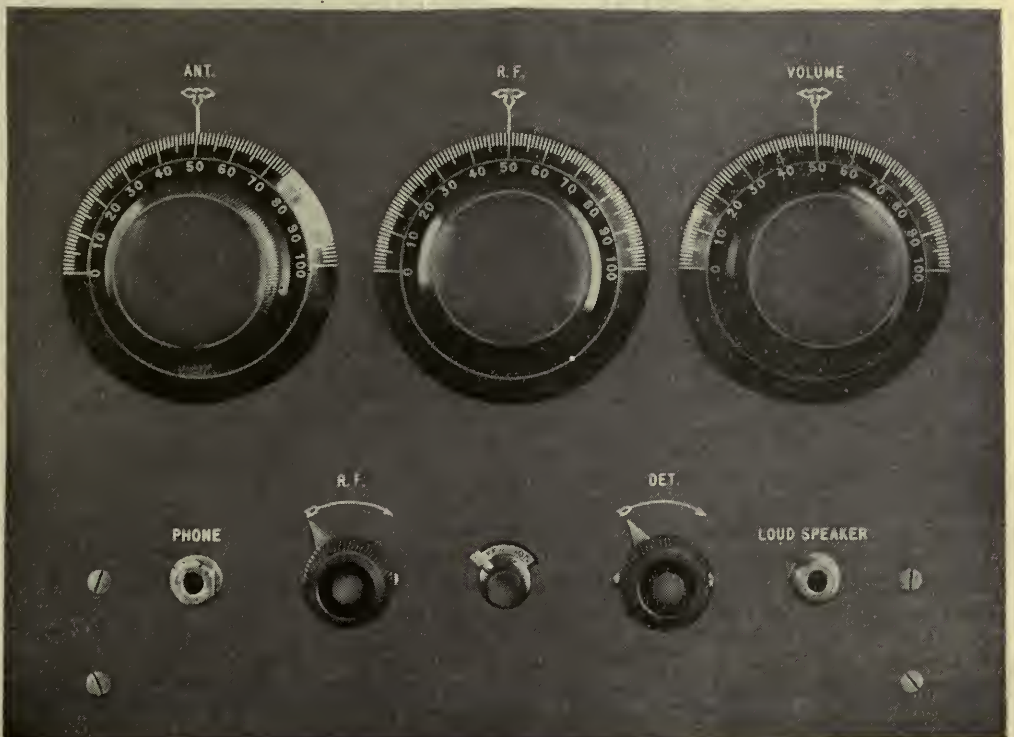
THE MAIN FEATURES OF THE PHONOGRAPH RECEIVER

FOLLOWING articles will show just how to build this receiver, down to the very last binding post and drop of solder. The photographs which are reproduced with this story show just what we have been able to do with the Phonograph Receiver and several representative types of phonograph cabinets. For the experienced radio constructor, the photographs are self explanatory, but for the builder who sets great store by complete constructional details and diagrams, the later articles will show exactly how it is done.

The main feature of the Phonograph Receiver is its wonderful compactness. The panel layout, as you will observe, is extremely symmetrical. The assembly of the parts is not particularly difficult and the results which we have obtained with several models with which we have been experimenting have been highly satisfactory. This Phonograph Receiver combines all the good features of the Four-Tube Knockout, plus some very significant mechanical and electrical improvements. By referring to the announcement of the Better Receiver Contest, which appears on another page of this magazine, you will find listed the qualifications which the Roberts Knockout receiver possesses. We believe that tube for tube, dollar for dollar, and result for result, this is by far the best receiver ever designed for home construction.

After we had satisfied ourselves that we had the best possible receiver for the purpose, the next most important point was the actual mechanical layout of the parts. In this, we feel, we have been highly successful.

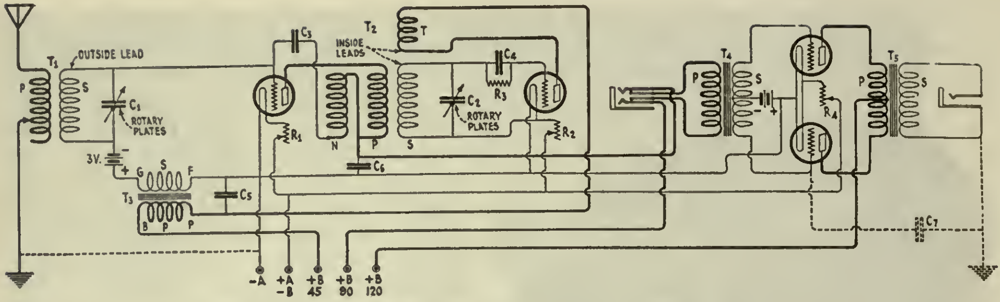
FIG. 9. A SIMPLE METHOD OF CONVERTING THE TONE CHAMBER OF A PHONOGRAPH INTO A LOUD SPEAKER



Radio Broadcast Photograph

FIG. 10. THE UNIT ON A SMALLER PANEL

This model was made to illustrate the points outlined in Fig. 8 and shows a very symmetrical panel design. The application of a unit like this to any phonograph is a very simple matter. It is merely necessary to procure a piece of five ply veneer large enough to fill the desired space, cut a hole in wherever the unit will fit most satisfactorily and set it in place. If, to conserve space, it is necessary to install the receiver in a sidewise position, the precaution concerning the position of the tube sockets to prevent sagging filaments touching the grids must be taken into consideration and the mounting of the sockets changed accordingly. The engraving may then be put on the proper part of the panel to make reading the dials from the side unnecessary



FIGS. 11–12. THE SIMPLEST WIRING ARRANGEMENT

Is shown in Fig. 11. It differs from Fig. 12, (below), in several minor details. Simple jacks are used instead of those incorporating the filament control feature. A rheostat controls the filaments in the push-pull tubes instead of the Amperites. This circuit is a much simpler wiring job but where the receiver is to be used by the entire family the additional wiring necessitated by Fig. 12 will be found very much worth while. The dotted lines in both these diagrams illustrate simple and effective methods for overcoming any difficulties which may arise in the audio amplifiers such as a continual whistle which was observed when certain transformer combinations were used

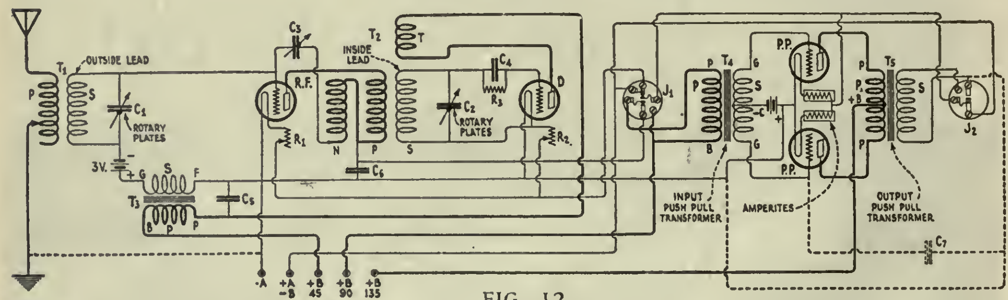


FIG. 12

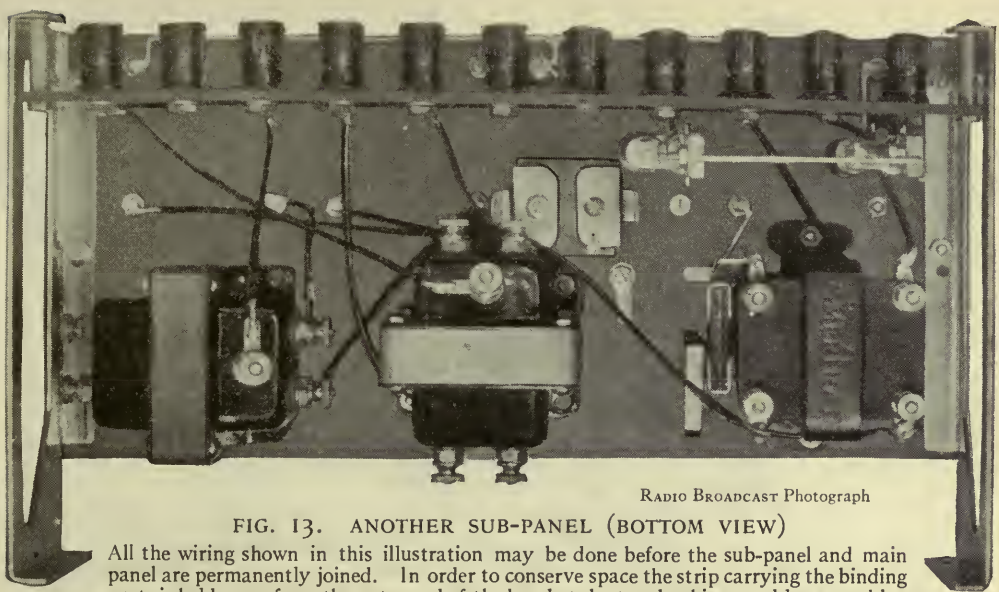
The possibilities of this Phonograph Receiver are best shown by an examination of the accompanying illustrations.

A great many Victor phonographs of the upright type are in use to-day. In these, the record cabinet is of two kinds. Some have two sets of shelves; the upper holding books for ten-inch records and the lower holding books for twelve-inch records. In order to fit the Phonograph Receiver in such a cabinet, it is merely necessary to remove the upper shelf and find some other convenient place for them. An unused corner of a bookcase does very well. A panel of wood or some composition is then made to fit the space previously occupied by the record-books and the receiver-unit is then fitted directly to this panel, or to a sub-panel mounted on the panel which is substituted for the record-book shelf.

The illustrations show that this radio-phonograph combination will save a great deal of space, and since the storage battery and the B batteries may be included in the phonograph itself they are permanently placed out of sight. This is, of course, impossible when the radio set is used on some sort of table

In another upright Victor model, there are a series of four to six shelves used to hold the phonograph records, with books to contain them. In placing the Phonograph Receiver in such a cabinet, it is only necessary to measure about twelve inches down from the upper end of the record space, remove the shelves and have a panel of wood or composition made to fit this space.

There are a great many receiver devices now on the market which enable one to use a so-called loud speaker attachment with the phonograph. These devices are connected to the audio output of the receiver and the unit itself mechanically coupled to the tone-arm of the phonograph. The sound compartment of the phonograph is used as the loud speaker. This operation is very simple, as can be seen from one of the illustrations. The character of the signal resulting from the use of a good loud speaker attachment and the phonograph itself as the "loud speaker" is extremely good. There are also some new types of tone-arms which combine both the tone arm for the phonograph and an attachment for employing the loud speaker unit. In such a combination, the phonograph or loud speaker attachment



RADIO BROADCAST Photograph

FIG. 13. ANOTHER SUB-PANEL (BOTTOM VIEW)

All the wiring shown in this illustration may be done before the sub-panel and main panel are permanently joined. In order to conserve space the strip carrying the binding posts is held away from the outer end of the brackets by two bushings and long machine screws. The space saved in this way is nearly $\frac{3}{4}$ of an inch. Units like this completely wired are soon to be placed on the market. The Radio Research Laboratories, New York City, are the originators of this unit idea. It would be well to compare this illustration with Fig. 7 to note the changes

may be used at will without taking the sound box from the tone arm. A tone-arm of the sort described has been used in our laboratory and has produced very satisfactory results.

In our experiments with this new design, we have used a great number of different radio parts designed for the same purpose. In practically every case, the overall efficiency of the resulting models has been substantially the same. For example, we have used a number of different types of transformers. We have used various kinds of coils, various makes of rheostats, and vacuum tube sockets. We have not as yet been able to use standard jacks in this receiver, although we are working on that problem now. It may, perhaps, be difficult for some of our readers to secure circular jacks as used in these Phonograph Receivers in their locality, but these may be obtained by mail order in a few days from almost any part of the country.

What we are trying to do is to present a design, which in the final analysis will give satisfaction, even in the hands of an inexperienced person. We are trying to make it possible for the home constructor to obtain the necessary parts without putting himself to a great deal of trouble. By incorporating as we have, well known, standard parts, we have made it possible for the radio dealer to supply all the necessary units for this receiver with a minimum of trouble.

All those who have seen the first models of the RADIO BROADCAST Phonograph Receiver are unanimous in agreeing with us that it fills a distinct need of the home constructor. The next article will describe the building of this receiver.

See Important Special Announcement on Page 278

QUERIES ANSWERED

What is the function of a detector tube?
A. G. N.—Atlanta, Ga.

Will you publish a circuit on impedance—coupled audio-frequency amplification?
L. P.—San Antonio, Tex.

What is the circuit diagram for including a 110-volt lamp in a B battery circuit for protecting the tube filament?
P. V. O.—Grand Rapids, Michigan.

What is the proper way to stain and polish a home-made cabinet?
N. D.—Nashville, Tennessee.

Explain in detail the use of the coil winding chart for determining condenser capacity,
J. H. W.—St. Louis, Mo.

Were the dimensions used for the panel in the construction of the two-stage radio-frequency amplifier in the May, 1925, issue of Radio Broadcast correct?
L. G.—Chicago, Ill.

HOW A DETECTOR TUBE "DETECTS"

THE term detect is somewhat erroneous when used in describing the function of a vacuum tube detector. If our ear mechanisms were able to respond to radio signals as they are transmitted, there would be no need for detector tubes.

However, the frequency, or in other words, the rapidity with which the radio vibrations are produced, is too great for us to hear, so that some means of reducing the number of vibrations must be employed. The action is one of rectification rather than one of detection. For instance, the maximum number of vibrations that can be heard by the human ear is about 20,000 cycles, while the minimum number that can be heard is but 16 cycles.

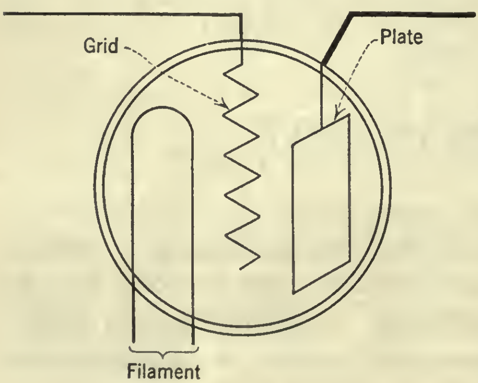


FIG. 1

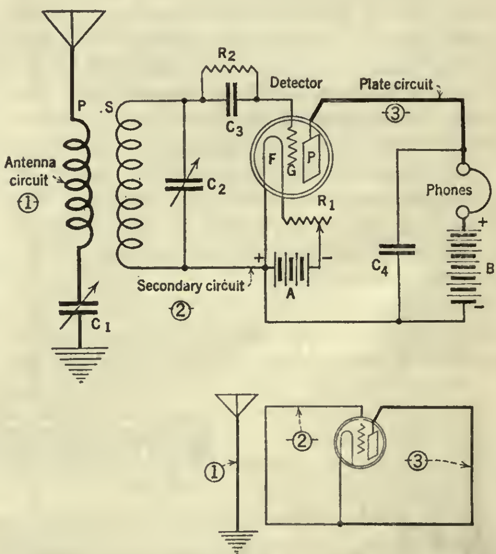
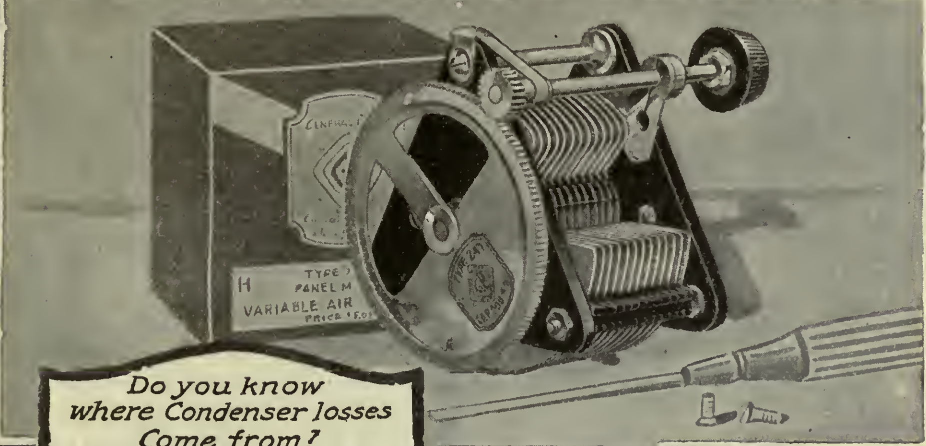


FIG. 2

Facts! not Fancies!



Do you know where Condenser losses Come from?

RESISTANCE LOSSES are the losses which most seriously affect the efficiency of a condenser when at working radio frequencies. They arise from poor contacts between plates and from poor bearing contacts. Soldered plates and positive contact spring bearings reduce these losses to a minimum.

Eddy current losses occur in metal end plates and the condenser plates themselves. While not so serious as resistance losses, they increase with the frequency, and therefore should be kept as low as possible.

Dielectric losses are due to absorption of energy by the insulating material. Inasmuch as they vary inversely as the frequency, they have less effect upon the efficiency of a condenser at radio frequencies than any other set of losses. The use of metal end plates in short-wave reception to eliminate dielectric losses is never justified, because they introduce greater losses than well-designed end plates of good dielectric.

The design of General Radio Condensers is based on scientific facts and principles, not on style and fancies.

Specially shaped plates always in perfect alignment give the uniform wave-length variation which permits extremely sharp tuning.

Rotor plates are counterbalanced to make possible accurate dial settings.

In 1915 the General Radio Company introduced to this country the first Low Loss Condenser, and ever since has been the leader in condenser design.

Lower Losses and Lower Prices make General Radio Condensers the outstanding values of condenser design.

Licensed for multiple tuning under Hogan Patent No. 1,014,002

Type 247-H, with geared Vernier Capacity, 500 MMF. *Price* $5.00

Type 247-F, without Vernier Capacity, 500 MMF. *Price* $3.25

GENERAL RADIO CO.
CAMBRIDGE, MASS.

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GENERAL RADIO

Quality Parts

★ Tested and approved by RADIO BROADCAST ★

Now waves of greater or lesser frequencies than this must be either increased or reduced before they can be heard. To accomplish this purpose, a detector, or rectifier, is used, which breaks up the frequency of the oscillations into groups and makes it possible to hear the vibrations as they are recorded on the telephone diaphragm.

The elements of which the tube consists are (A) a filament which is energized by a source of direct current (storage A battery.) Around this filament is (B) a wire mesh or grid. Then outside and around the grid is (C) a metallic member termed the plate. These elements are supported by wire rods imbedded in a glass tube from which the air has been evacuated. Convenient contacts are provided by prongs protruding through the base.

Diagrammatically, the vacuum tube is represented as in Fig. 1 while Fig. 2 shows a vacuum tube connected in an ordinary receiving circuit.

The action of the circuit and the function of the tube are as follows:

The antenna circuit consisting of the antenna, primary, the variable condenser and the ground, have been adjusted to the wavelength of a transmitting station.

The secondary circuit, S-C^2, to which is connected the vacuum tube, its batteries and phones, is tuned in resonance with the primary.

This makes it possible to receive energy in the antenna circuit so as to set up an electro-magnetic

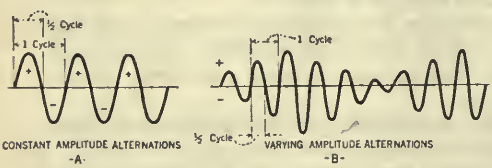

FIG. 3

field, which induces a voltage in the secondary circuit.

Now, by referring to Fig. 2, it will be seen that there are, primarily, three parts to the circuit.

When the filament is lighted to incandescence it emits electrons which flow to the plate, so that when a signal is received, it sets up in the antenna circuit an electro-magnetic field, due to the variations in amplitude of the received signal. See Fig. 3A and B. This field induces in the secondary, or grid circuit, a voltage which charges the grid condenser.

Doctor Van der Bijl explains the succeeding rectifying action as follows:

> "When the grid potential becomes positive, electrons are attracted to the grid and during the next half cycle when the grid potential becomes negative, the electrons cannot escape from the grid, because they are trapped on the insulated part of the circuit comprising the grid and the one plate of the condenser C3. During the next positive loop of the incoming wave the grid attracts more electrons, which are also trapped so that they cannot escape from the grid during the succeeding negative loop. In this way, the grid builds up a negative potential, and the high frequency potential variations on the grid, vary around a mean value of the grid potential, which becomes more and more negative as the strength of the incoming oscillations increase. This reduces the

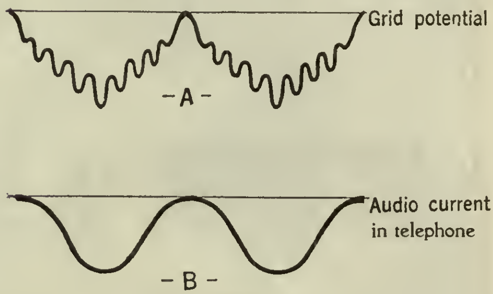

FIG. 4

> plate current, and if the condenser C3, and the insulation of the part of the circuit comprising C3 and the grid were perfect the plate current would be permanently reduced and this would make the tube inoperative. To prevent this, a high resistance leak, R2, is shunted across the condenser, its value being so proportioned that the electrons cannot leak off this resistance to any appreciable extent in a time comparable with the period of the high frequency oscillations. But the electrons do leak off in the time of the order of magnitude of the low frequency variations of the amplitude of the high frequency oscillations. The result is, that the potential of the grid takes such values as are represented by the curve in Fig. 4A. The high frequency variations in the plate circuit pass through the condenser C4 inserted in the output circuit, and the current in the telephone receiver takes the shape shown by the curve in Fig. 4B."

The current passing through the phones energizes the electromagnets and conforms with its

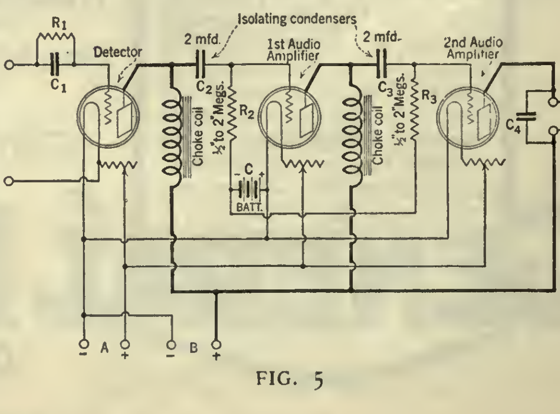

FIG. 5

As positive as Big Ben

Cutlass Stator Plate exclusively an Ultra-Lowloss feature

A guarantee of satisfaction and Lacault design

SET Big Ben at seven and at seven o'clock you're bound to get the alarm.

Just so, the Ultra-Lowloss condenser can be set at any wavelength—the corresponding station will come in clear and sharp. You know instantly where to turn, once a station of known wavelength is located. Makes tuning easy—direct—positive. Special Cutlass Stator Plates spread wavelengths evenly over a 100 degree scale dial so that each degree represents approximately $3\frac{1}{2}$ meters.

Ultra-Lowloss condensers are designed by R. E. Lacault, originator of the famous Ultradyne Receivers, and built upon scientific principles which overcome losses usually experienced in other condensers.

At your dealers, otherwise send purchase price and you will be supplied postpaid.

Design of lowloss coils furnished free with each condenser for amateur and broadcast wavelengths showing which will function most efficiently with the condenser.

To Manufacturers Who Wish To Improve Their Sets

Mr. Lacault will gladly consult with any manufacturer regarding the application of this condenser to his circuit for obtaining best possible efficiency.

★

ULTRA-VERNIER
TUNING CONTROL

Simplifies radio tuning. Pencil-record a station on the dial—thereafter, simply turn the finder to your pencil mark to get that station instantly. Easy—quick to mount. Eliminates fumbling, guessing. Furnished clockwise or anti-clockwise in gold or silver finish. Gear ratio 20 to 1.

Silver, $2.50 Gold, $3.50

ULTRA-LOWLOSS
CONDENSER

PHENIX RADIO CORPORATION - 116-C East 25th Street - New York

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strength, actuating the diaphragm which produces sound vibrations which are audible to the ear.

IMPEDANCE-COUPLED AUDIO AMPLIFICATION

FOR those who wish to experiment with choke coil audio amplification, the circuit in Fig. 5 is especially interesting.

A detector and two-stage amplifier is shown.

In the plate circuit of the detector and first stage amplifier, the variations in voltage drop take place in the choke coils. These variations are impressed on the grid of the succeeding tube through the large isolating condenser. In the amplifiers the grid leaks connected from the grids to the negative side of the filament (through a small C battery) furnish a path for excessive negative voltages, which are accumulated on the grid, to leak off.

The choke coil may be the secondary of an audio transformer. Usually transformers having burned out primaries may be found in the junk box of the radio laboratory which will fit in nicely here.

The small C battery applies a negative bias on the grids which permits the amplifier tubes to operate on the proper point on their characteristic curve.

The value of an isolating condenser is such that a minimum of voltage loss is effected by its use.

Besides being a coupling agent between the plate and grid of adjacent tubes, this condenser isolates the high B voltage from the grid of the tube.

The values of the parts are C1 .00025 mfd., C2 2 mfd.; C3 2 mfd.; C4 .001 mfd: R1 3 megohms; R2 and R3 $\frac{1}{2}$ to 2 megohms.

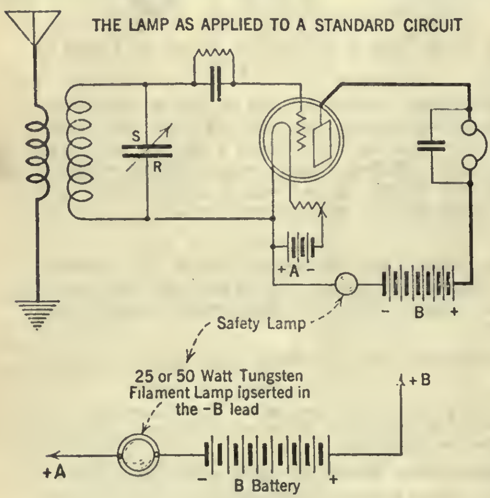

FIG. 6

A TUBE PROTECTOR

VERY often radio tubes are consigned to the junk heap because some too enthusiastic experimenter was not careful enough to keep his high voltage B battery leads away from the filament circuit of his receiver.

By the simple addition of a 25 or 50 watt lamp inserted in the negative B battery lead (Fig. 6), tubes may forever be protected from blow-outs. Ordinarily the negative side of the B battery connects to either the plus or minus of the A battery.

Assuming that the connection is made to the plus A, if the plus B should happen to come in contact with the minus A, then 45 or 90 volts (as the case may be) would be applied to 6 volt filaments. Result: blown out tubes.

Now, by placing the lamp in the negative side of the B battery, the full voltage of the battery is applied to its filament thereby choking off the B current and so protecting the tube filaments due to the relatively high resistance of the lamp being inserted in series in the circuit. The tungsten type of lamp seems to give better results than the carbon filament type. Ordinarily if the plus B lead should touch the plus A lead then the B battery would become short-circuited, but if the lamp is in the circuit it will indicate the connection by lighting brilliantly.

STAINING AND POLISHING CABINETS

THE true constructor must know a bit about the carpentry that enters into the make-up of a receiver. The art of carpentry is closely allied with the radio art as is manifest in the elaborate cabinet designs now so plentiful in the radio market.

For the home-constructor, a few pointers on staining and polishing will not be amiss. There are several kinds of stains, namely, the alcohol stain, the penetrating stain, and the oil stain. The first two named seem to act better for quality work, although no doubt good work may be accomplished with oil stain. This discussion will apply only to the penetrating and alcohol stains.

The equipment needed is as follows:

1. A small supply of alcohol—one pint.
2. Stain.
3. Cheesecloth pad made with cotton waste.
4. Steel wool.
5. Rotten stone.
6. Wax (in powdered or grease form).
7. Shellac—one-half pint jar.

The cabinet is first coated evenly with the stain until the desired shade is obtained. Shellac is applied with the cloth pad so that the entire surface is covered. Then with the alcohol, the surface is lightly washed, which removes much of the surplus shellac. After this coat is allowed to dry for about twenty minutes, another coating of shellac is applied which is again washed down with the alcohol. This is repeated until the desired surface effect is obtained. Then, with rotten stone the surface is fully cleaned, after which it is rubbed down by the steel wool. Finishing touches consist of polishing with a waxed cloth.

THE COIL WINDING CHART FOR CALCULATING CAPACITY

IN LAST months' RADIO BROADCAST, a chart for the computation of coil sizes was described on page 46, which would aid the experimenter in determining the proper size coil required where

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WEAF	New York	WEAR	Cleveland
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Evereadys have long-lasting power

THE long-lasting power of Evereadys more than justifies their price. It is false economy to buy batteries that may be cheaper in first cost, but which are much shorter lived. Considering price and size, Evereadys are the most economical batteries there are, and in addition they are most satisfactory. Buy Eveready "B" Batteries. To light the filaments of all radio dry cell tubes, use the famous Eveready Columbia Ignitor.

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NATIONAL CARBON COMPANY, Inc.
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EVEREADY
Radio Batteries
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★

Eveready Columbia Ignitor "A" Battery The proven dry cell for all radio dry cell tubes 1½ volts

No. 766 22½-volt Large Horizontal Price **$2.00**

No. 772 45-volt Large Vertical Price **$3.75**

No. 764 22½-volt Medium Vertical "B" Battery Price **$1.75**

a certain sized condenser was designated to tune a circuit to a predetermined wavelength range.

In the article it was mentioned that the chart might be used in the reverse manner, where the coil size and wavelength range desired were known, to determine the value of variable condenser needed to accomplish this end.

In detail this reverse operation is described as follows:

Count the number of turns per inch on the coil and measure its length. On the chart connect these two points by a pencil line. Then determine the diameter of the coil and at that value on the chart and draw a line to intersect with the one previously drawn, at the index line and at the inductance scale.

Then by knowing the inductance value, since it is indicated by where this last line touches the inductance scale, and by knowing the maximum wavelength range desired, we draw a line between these two points and continue the line on to the capacity scale. This intersection at the capacity scale gives us the maximum capacity of the variable condenser necessary for tuning the coil in question to the maximum wavelength indicated.

CORRECTED DIMENSIONS

THE dimensions for the panel used in the construction of the two-stage radio-frequency amplifier described in the May, 1925, issue of Radio Broadcast Magazine should read as follows: Panel 7 inches wide, 18 inches long, and $\frac{3}{16}$ inch thick.

Before You Write to the Grid

THOUSANDS of you are writing the Grid for technical advice every month. The expense of framing a complete and exhaustive reply to each letter is very high. The editors have decided that the benefit of the questions and answers service will continue to be extended to regular subscribers, but that non-subscribers, from April 15, on, will be charged a fee of $1 for each letter of inquiry which they send to our technical department. Very frequently, our technical information service proves of definite money value to you who write us, for we are often able by a sentence or two of explanation, to put you on the right path before you have made a perhaps expensive mistake.

The occasional reader of RADIO BROADCAST will be charged a fee of $1 for complete reply to his questions, and the regular subscriber can continue to take advantage of the service as before. In that way the non-subscriber will help share the cost of the technical staff whose service he gets. Every letter receives the benefit of the experience of the editor and the technical staff and every correspondent may be sure that his questions will receive careful consideration and reply.

When writing to the Grid, please use the blank printed below.

GRID INQUIRY BLANK

Editor, The Grid,
RADIO BROADCAST,
Garden City, New York.

Dear Sir:

Attached please find a sheet containing questions upon which kindly give me fullest possible information. I enclose a stamped return envelope.

(Check the proper square)

☐ *I am a subscriber to* RADIO BROADCAST. *Information is to be supplied to me free of charge.*

☐ *I am not a subscriber. I enclose $1 to cover costs of a letter answering my questions.*

My name is ____________________

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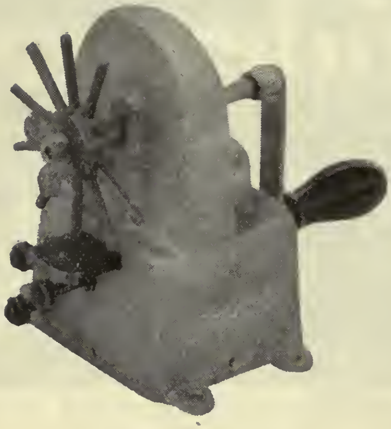
New Equipment



SEE—ESS WINDER

The winding of numerous inductances for experimental work is made easy with the above apparatus. The result is a self-supporting diamond weave coil of any desired inductance. A desirable addition to the constructor's laboratory. Distributed by the Wireless Electric Co., 204–206 Stanwix St., Pittsburgh, Pennsylvania. Price, $10.00

BELDEN LOOP WIRE

A wire composed of 60 strands of bare copper twisted with 5 strands of half hard phosphor bronze wire. This twist is then covered with cotton and finally with a good looking brown covering to match the better grades of loop frames. Made by the well known makers of wire, the Belden Manufacturing Company, Chicago, Illinois

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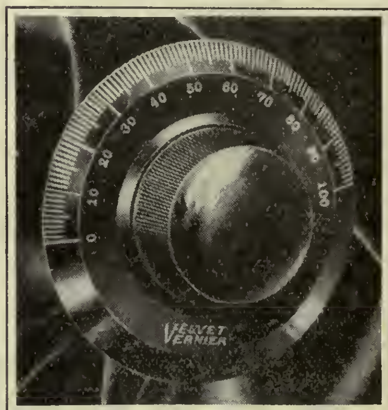
The unit of this speaker is of special construction, having a magnetically modulated diaphragm. Coupled with this is the horn which was developed to be as nearly correct acoustically, both as to shape and material, as possible. This reproducer covers practically the entire auditory range of sound waves very successfully. Made by the Kellogg Switchboard & Supply Co., Adams & Aberdeen Sts., Chicago, Illinois. Price, $20.00

"BALLGRIP" BINDING POST

These interesting binding posts represent a new idea in this field. Connections may be made instantly and the opening in the post is large enough for receiver cord tips. Springs force the ball to make good electrical contact when a wire is placed in position. The fact that there is no head to loosen and be lost is a decided point in its favor. Made by the Quality Moulded Products Inc., Jersey City, New Jersey



VELVET VERNIER DIAL

An all-vernier dial with a ratio of approximately four to one and is entirely free from back-lash. With this dial you not only enhance the appearance of your receiver but also make tuning very easy. Made by the National Company, Inc., 110 Brookline St., Cambridge, Massachusetts

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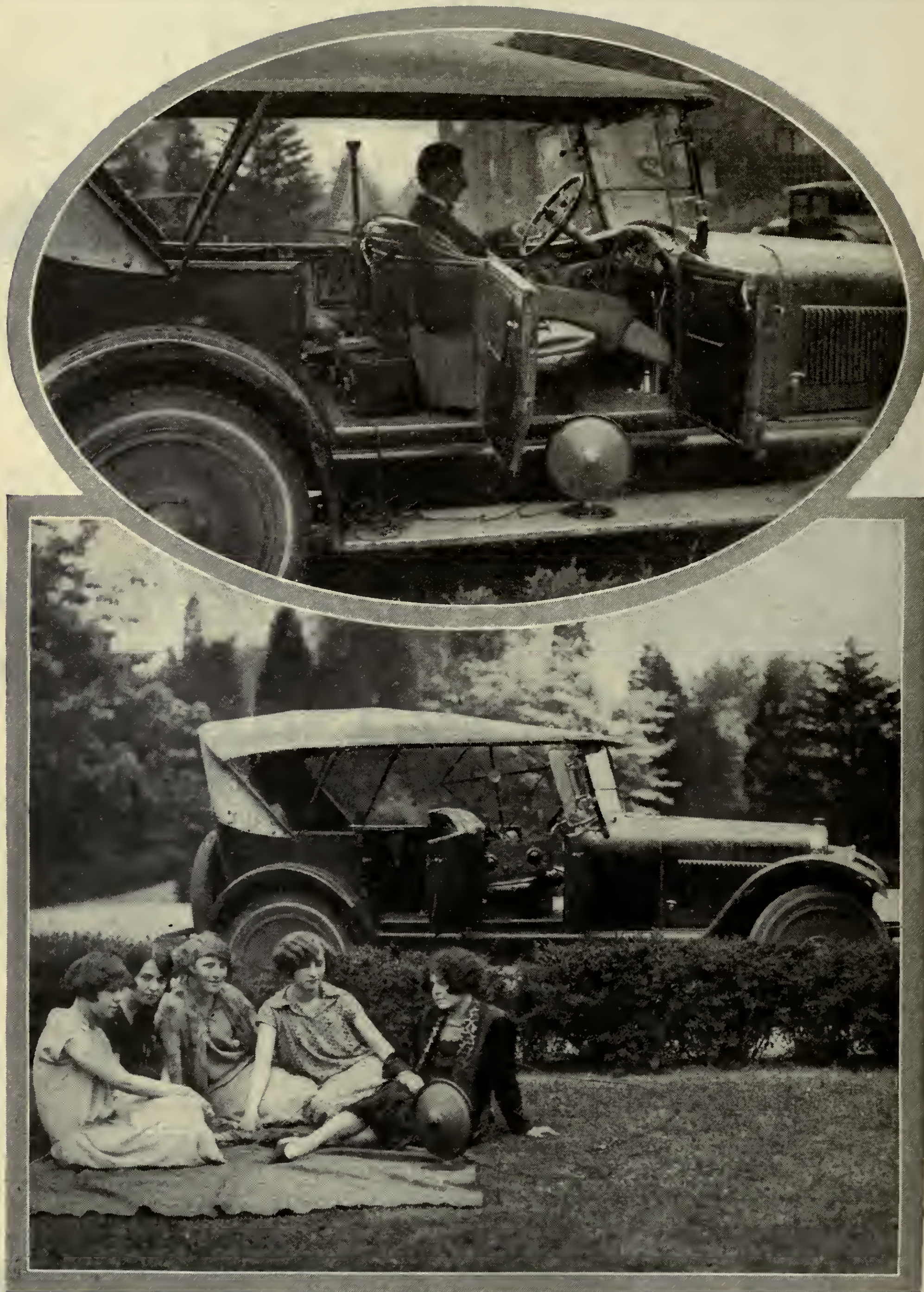


SUMMER-TIME RADIO

The super-autodyne described in this issue is made portable by use of the Lynch Lead which connects the filaments to the automobile battery. The Crosley "Musicone" is connected by a long cord so that the receiver may be left in the car and the speaker taken to any convenient spot nearby. It is growing more and more fashionable to make a portable set a part of motoring and camping equipment

RADIO BROADCAST

Vol. 7, No. 3 July, 1925

Will "Beam" Stations Revolutionize Radio?

Senator Marconi's Own Story of His Experiments with Short Waves—Increased Efficiency and Greater Sending Speed Made Possible by Focussed High-Power Short Waves

By GUGLIELMO MARCONI

THE art of radio communication might well adopt as its motto, paralleling a well-known Roman saying about Africa, "*Ex radio semper aliquid novi*," or, to put it in the vernacular, "Out of radio we are always getting something new."

For many years, all the important radio communication enterprises of the world have been engaged in building larger and more powerful stations, employing many hundreds of kilowatts in order to be able to send forth into the ether more powerful and longer electric waves, which have, in some cases, reached a length of about 15 miles. But had a little more time been devoted to a systematic investigation of short waves, produced by a power equal to only a fraction of that used in all of the big stations in the world, the discovery might have been made that a modest 100-foot wave, utilizing only some 15 kilowatts or 20 horse power, could successfuly travel from England to Australia and South America, even during daylight, and there reproduce easily decipherable telegraphic signals.

But most experts, relying on theories which had not been thoroughly tested or on insufficient experimental data, had made up their minds as to what short electric waves could or could not do. It was reserved for the years 1923 and 1924 to show conclusively that such short waves could, and did, perform efficiently and reliably most of the things which the experts had considered until then either impossible or impracticable.

I think I am justified in saying, as a result of the experiments which I have carried on for a number of years and which culminated in 1923 and 1924, that a combination of short electric waves with what is known as the Beam System, is likely to bring about what amounts to nothing less than a revolution in the methods of commercial long-distance radio communication.

SHORT WIRELESS WAVES ARE HISTORICAL

THE use of short electric waves is as old as the discovery of the waves themselves. Hertz made use of them in his first classical experiments, and he proved that they obeyed the same laws as the infinitely shorter light

waves in regard to the speed of propagation, reflection, refraction, and diffraction. Some twenty-nine years ago in my own first experiments, in Italy, and shortly afterward in England, I used short waves in combination with metallic reflectors and, curiously enough, I was then able to transmit signals with them over a distance of a mile and three quarters, while with the elevated antenna and much longer waves, i. e., using the same system that is used to-day in all the high-power stations of the world, I could only manage to communicate over a distance of half a mile.

It is perhaps regrettable that the subsequent rapid development of the long-wave system, which in three or four years achieved such spectacular results, drew away the attention of most of us not only from the possibilities of the short waves, but also from the use of suitable reflectors to concentrate them into a beam in a definite direction, which is possible only with short waves. I never quite abandoned the idea, however, of utilizing the latter and, in addition, I always realized the importance of evolving a practical directive system of radio communication.

I believe it is generally admitted now that electric waves are far too valuable to be always allowed to spread out in every direction when it is desired to communicate with only one particular place. If a station in Great Britain wishes to communicate with one in the United States, for example, there seems to be no good reason why, if it can be helped, what it has to say should be heard in Siberia, and Egypt, as well as in Nicaragua and India. Naturally, non-directional stations, which scatter their waves in every direction, are of great utility for many naval and war purposes, and of course for broadcasting, where the very soul of the process lies in the fact that the waves are scattered all around to be picked up by any one with a suitable receiving set. But it has always seemed to me that, if possible, the right thing to do would be to concentrate the whole of the radiated energy into a beam directed toward the locality with which it is desired to communicate, just as the beam of light waves from a searchlight is thrown in one direction by means of reflectors.

Such a result is greatly to be desired on many grounds, such as the low cost of installation and economy of upkeep entailed by the much lower amount of energy required, the reduction of interference with other stations, and the comparative secrecy which can be obtained.

Economy of energy is a matter which is instantly translatable into pounds, shillings, and pence. If we consider a high-power station similar to the one recently built in the Argentine for communication with Europe over a distance of about 6000 miles, every time the operator depresses the key and sends a signal flashing through the ether, some 800 kilowatts (about 1100 h. p.) is expended, although in the case of these long waves, only a small fraction of the power is radiated from the antenna, which, in this case, is supported by ten steel towers each 690 feet high. It is evident that if a signal as easily readable can be sent with 30 or 40 kilowatts (about 50 h. p.) and by means of an antenna supported by much lower and fewer masts, there will be not only a greatly decreased cost of installation of the station, but also a great reduction in the cost of maintaining the station.

With regard to the question of interference

What Senator Marconi Is Doing

On his last trip to the United States, Senator Marconi presented a paper before the Institute of Radio Engineers describing various radio experiments being conducted under his direction. That paper was read June 30, 1922, and dealt to a large extent with experiments with short radio waves.

It should not be thought that short wave radio transmission is new, simply because experiment in this field has lately received a good deal of attention from amateur and commercial engineer alike. Senator Marconi's earliest experiments with wireless waves in 1895 and 1896 used waves not more than a few inches long. And now, after radio stations have been built to use waves as long as 20,000 meters, the cycle of radio investigation swings back to something very similar to that of the first radio experiments. But in these experiments, the aim is to do away with the fading and absorption of signals, interference by natural electric waves, and to make transmission directional. In this article, Senator Marconi himself tells of what he and his engineers have lately done to revolutionize radio.—The Editor

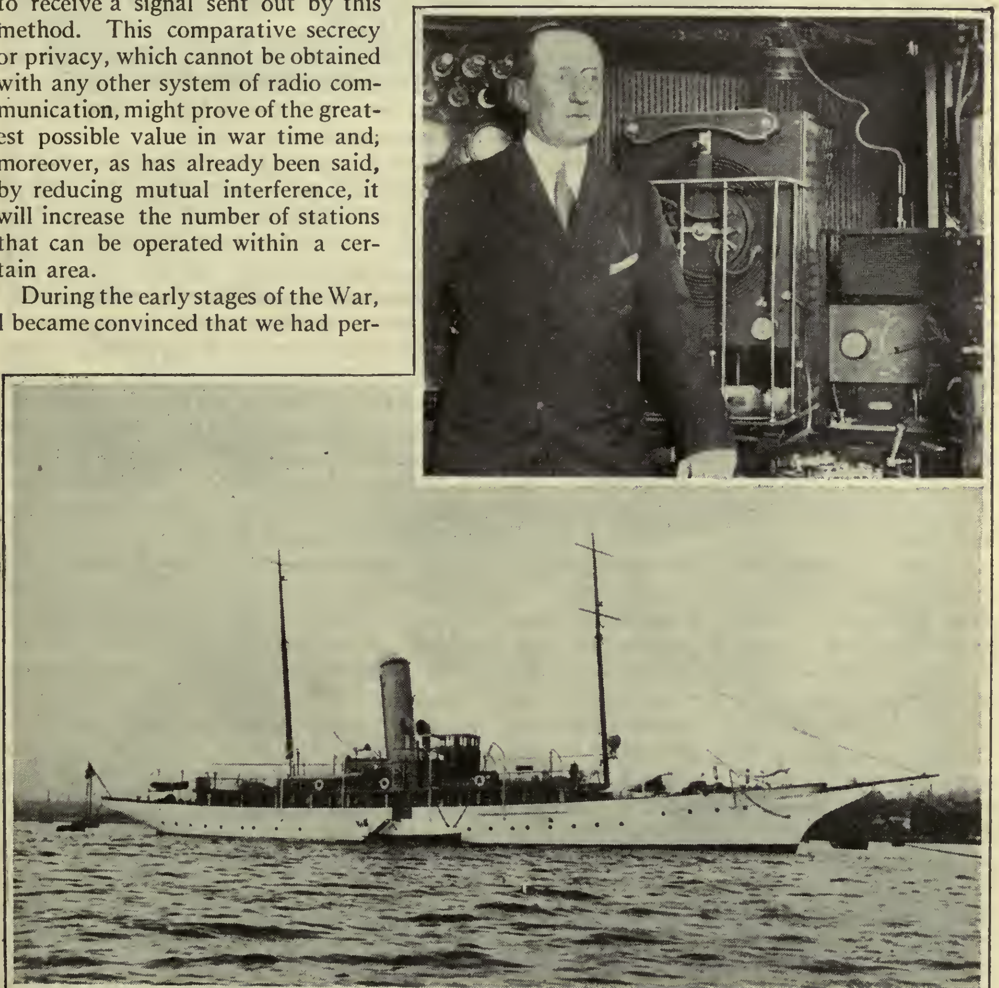
with other stations, it should be remembered that the number of available wavelengths is, after all, far from being unlimited, and if Brazil wishes to let New York know the prices of coffee and rubber on a certain wavelength, it would seem useless and, in certain cases, perhaps, undesirable, to broadcast the same information over Africa, Europe, the Pacific Ocean and probably a large part of Asia.

BEAM RADIO TRANSMISSION IS MORE SECRET

AS REGARDS secrecy, the beam system possesses a considerable advantage because only places situated within a certain angle or sector of the beam are able to receive a signal sent out by this method. This comparative secrecy or privacy, which cannot be obtained with any other system of radio communication, might prove of the greatest possible value in war time and; moreover, as has already been said, by reducing mutual interference, it will increase the number of stations that can be operated within a certain area.

During the early stages of the War, I became convinced that we had permitted ourselves to get into a rut by allowing our attention to be monpolized almost exclusively by long waves, and I decided to take up the systematic study of short waves in combination with arrangements for directing them in any given direction. My first experiments along these lines in Genoa and later in Livorno in 1916, showed me that good directional working could always be obtained with properly constructed reflectors, and with the apparatus then available a range of six miles was attained.

Further experiments, carried out by my assistant, Mr. C. S. Franklin, between Carn-



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THE "ELETTRA"

Senator Marconi's floating radio laboratory and pleasure yacht. Much of this great investigator's most important work has been done aboard his yacht. Some of the experiments described in this article were made on the *Elettra* while she was in the Mediterranean, communicating with the station at Inchkeith, shown in the cut on page 327. The insert shows Senator Marconi in his radio cabin

arvon, in Wales, and Ireland, and subsequently between Hendon, near London, and Birmingham, increased this range to nearly a hundred miles and strong radio-telephonic speech was received with the use of a power of only 700 watts (less than 1 h. p.). One very important experiment led to the knowledge that, when suitable reflectors were used at both ends, that is, one reflector to concentrate and project the waves in a beam and the other to focus them at the receiving end on the receiving antenna, the received energy was some 200 times greater than when no reflectors were used.

The success of these experiments led me to carry out a series of tests between a small experimental transmitting station at Poldhu in Cornwall, and a receiver installed on my yacht, the *Elettra*, which would enable me to vary the distance between the transmitting and receiving ends at will. Until then, most technicians were under the general impression that the range of short waves during daytime was variable and short, and that though their night range was, as a rule, much greater, it was far too unreliable to be of any use for practical commercial work. In addition it was thought that any considerable mass of land, especially if it were of a mountainous nature, would very materially reduce the working range with them. My experiments, which were carried out chiefly with waves of about 100 meters in length, and with about 12 kilowatts (about 16 h. p.), served to disprove a considerable portion of these beliefs and theories.

I knew, of course, like every other experimenter, that short waves, or at any rate short waves of the length I was then using, had much shorter ranges during daytime than at night. This fact was first observed by me in February, 1902, and my subsequent discovery that waves of the order of several thousand meters would, on the average, work as well by day as by night, was one of the main contributory causes to the development of the use of long waves for long-distance communication.

In the 1923 experiments with the *Elettra*, however, I found that the day ranges were reliable and of a quite respectable magnitude, that the night ranges were much greater than any one, including myself, had expected, and that intervening land and large portions of continents, mountainous or otherwise, did not prove any serious obstacle to the propagation of short waves. I found also, which was extremely interesting and important, that "day-range" is not an accurate term as the strength of the signals received varies definitely and regularly in proportion to the mean altitude of the sun over the space between the two communicating stations. That is to say, the "day-range" depends on the particular time of day.

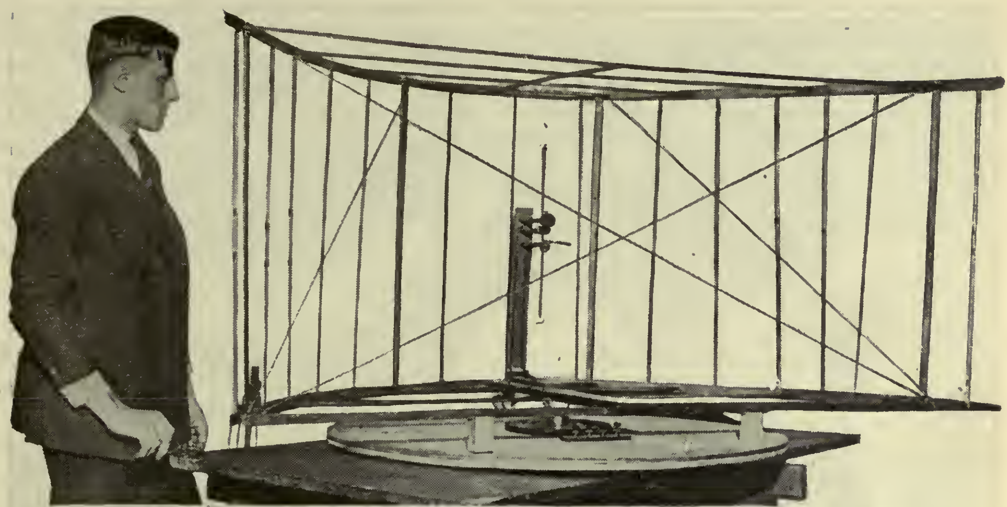
A TEST AT SEA WITH SHORT WAVES

WE STARTED off from Falmouth, and even when we reached Seville and were anchored in the Gudalquivir River, a very unfavorable position for reception, as the banks of the river were high and covered with trees and buildings, we found that the night signals were almost as strong as they had been in Falmouth Harbour, 12 miles from Poldhu, although at Seville, the whole of Spain, consisting of over 300 miles of high and mountainous land intervened between the sending and receiving stations.

When we reached the Moroccan coast at Casablanca, I gave instructions that the reflectors at Poldhu should be set up and we then proceeded to the Island of Madeira, and finally to St. Vincent, in the Cape Verde Islands where, at a distance of 2230 nautical miles, we continued to receive the night signals with such strength that it was nearly always possible to do without an amplifier or to disconnect the antenna or put it out of tune. In fact the signals were so extraordinarily strong that we never experienced the slightest trouble in consequence of static. The power then being used at Poldhu was about 12 kilowatts, and the reflector so concentrated the energy in the direction of the Cape Verde Islands that the strength of the signals was such that it would have required 120 kilowatts at Poldhu without the use of reflectors.

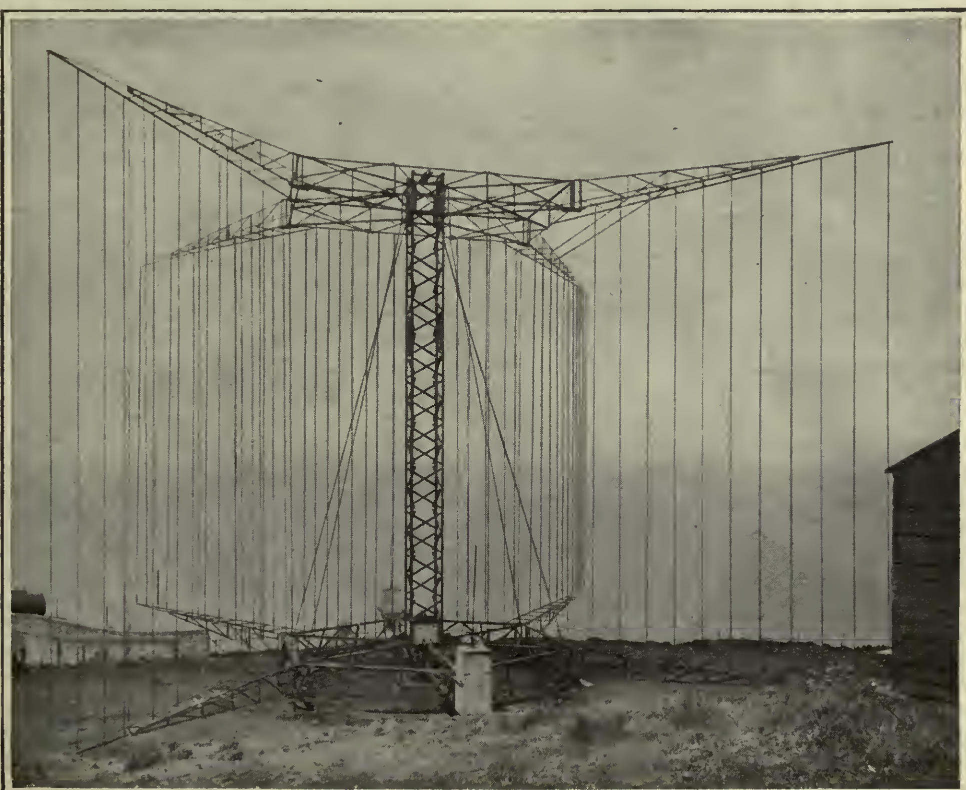
Because I was obliged to return to England without going any farther, I gave instructions to diminish this power gradually and found that with only 1 kilowatt (about $1\frac{1}{3}$ h. p.), the signals were still stronger than would have been required to carry on commercial work at night at that distance. It is interesting to note that these night signals, received at St. Vincent, even when Poldhu was using only 1 kilowatt, were much stronger than those which could be received from the high-power station at Carnarvon or the British Government station at Leafield (using 200 to 300 kilowatts) or from any of the other European or American high-power stations.

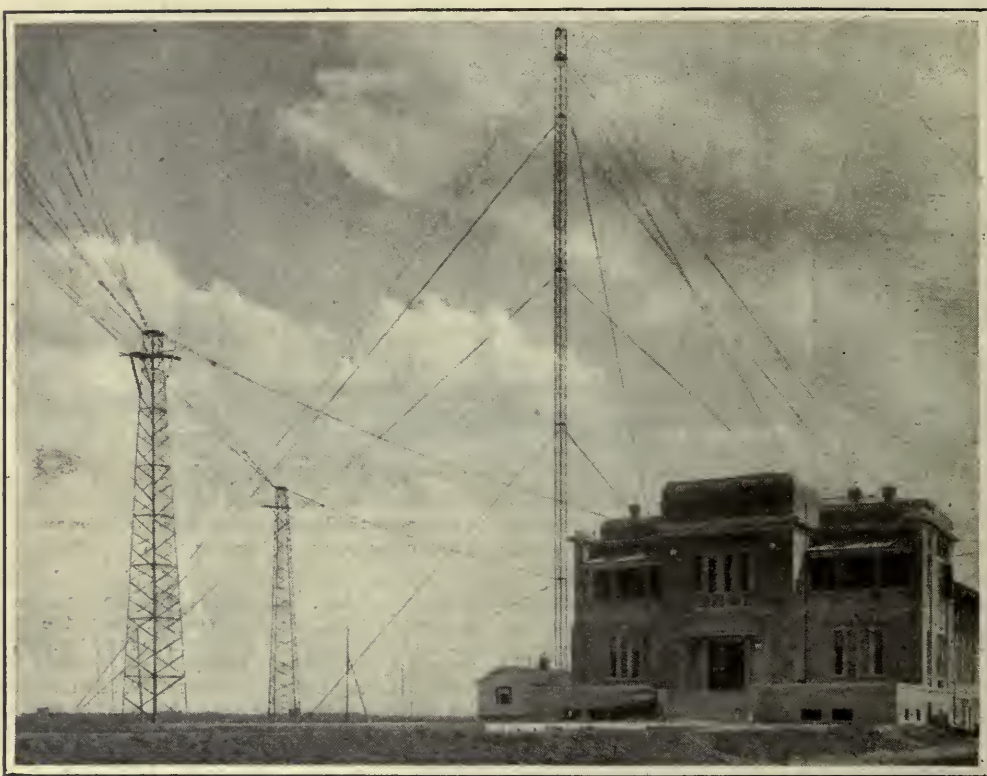
In view of these rather encouraging results, further tests were made early in 1924 between Poldhu, using some 17 kilowatts of power and



A REVOLVING BEAM TRANSMITTER AT INCHKEITH, ENGLAND

One of the experimental transmitters of directed radio energy used by Senator Marconi in his experiments between his yacht *Elettra* and England is shown in the photograph below. The main rigging on the towers is used as the reflector, while the transmitting antenna is very short and can be seen just above the two blocks at the outside of the circle at the base of the mast. This reflector can be moved so as to "mirror" signals in any desired direction. The photograph above shows a model of the beam transmitter used by Senator Marconi when he read a paper before the Institute of Radio Engineers at New York several years ago, explaining his beam experiments. The transmitting antenna is the short vertical wire at the center of the wire "mirror"





TRANSRADIO

The imposing towers of the new international station at Monte Grande, Argentina. The power house and masts are the center of the largest international radio telegraph station ever erected in South America. The towers are about 690 feet high. The smaller towers in the left foreground form an anchorage for the down-leads from the antenna. This station is for communication on long wavelengths and high power. The beam method of transmitting has not been applied to this station

waves of 92 meters and a special receiver installed on the White Star Liner *Cedric*. The result showed that during the daytime signals could be received up to 1400 nautical miles and confirmation was obtained that their intensity was dependent on the mean altitude of the sun at all times.

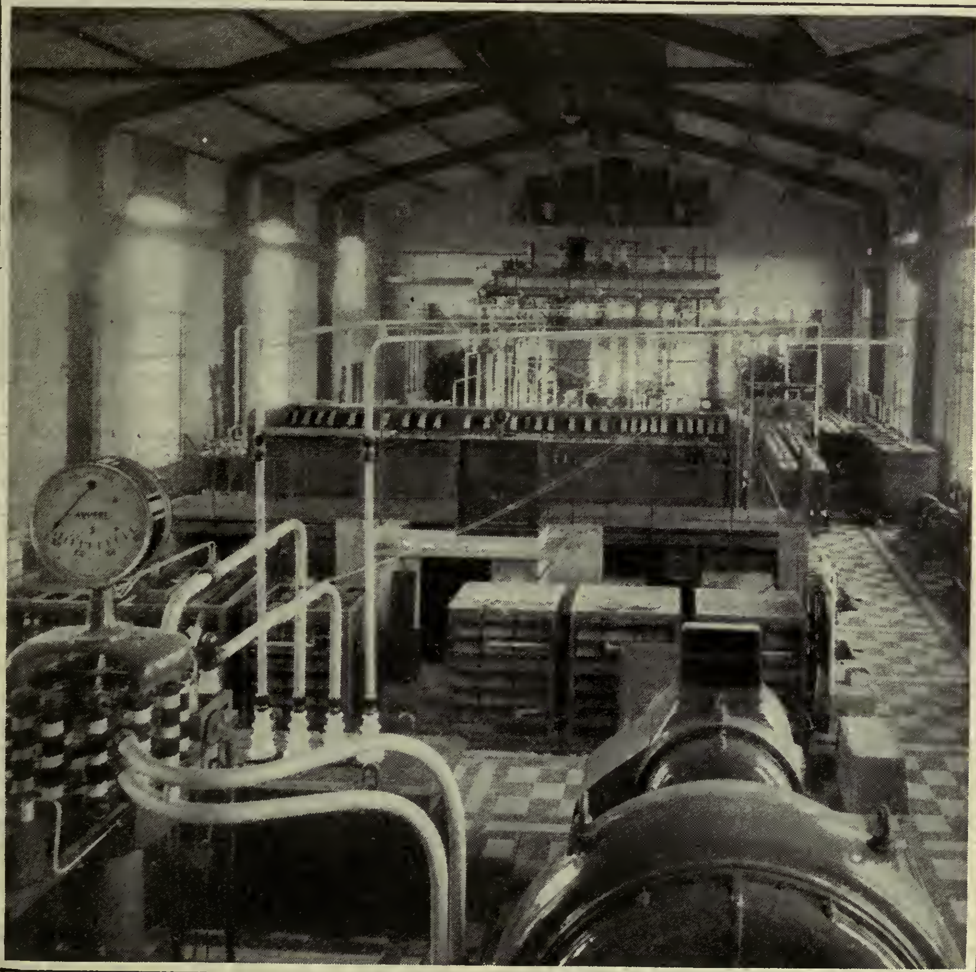
Advantage was taken of these tests to ask engineers of our associated companies in Australia, Canada, and the United States to attempt to listen to these transmissions from Poldhu and, rather to my surprise, it was reported to us from Australia, that they could be heard distinctly every day in Sydney, from 5 to 9 p. m. (Greenwich time) and again from 6.30 to 8.30 a. m., and this with what might be called an improvised receiver. If we consider the position and the altitude of the sun, the preference of short waves for traveling over regions not illuminated by the sun was made manifest, for it appeared quite obvious, that during the morning period, the waves traveled over 12,000 miles between England and Australia in a westerly direction across the Atlantic, America, and the Pacific, while during the evening period they must have traveled in an easterly direction across Europe and Asia, over the shortest distance, which is about 9380 nautical miles.

I was, however, by no means satisfied, for one of the essentials of a good telegraph system, whether it be with or without wires, is to be able to transmit the messages as soon as they are handed in and, therefore, the limitation of the period of working to practically the night hours constituted an undoubted disadvantage. That this was so, admitted of no doubt, so far as I had gone. For example, although the signals sent from Poldhu were received with great strength at New York, Rio, and Buenos Aires when darkness existed over the whole or the greater part of the track followed by the waves, no signals at all were received when the same

track or the greater part of it was exposed to the light of the sun. Even an increase of power or the use of reflectors augmented the working hours very slightly. I had the impression of being faced with conditions analogous to those produced by a fog on the transmission of light. If the fog be thick enough, no matter how much the luminous intensity is increased, the light waves fail to penetrate it for any considerable distance.

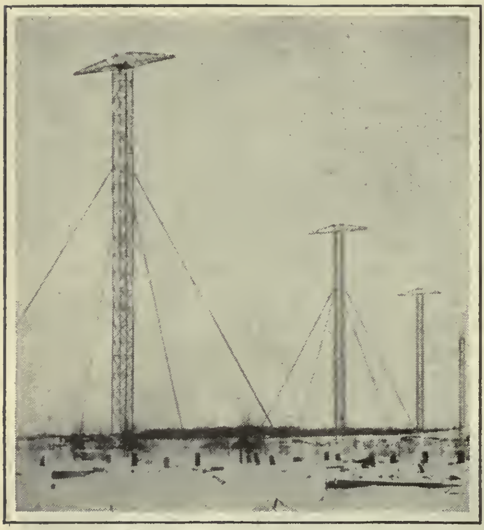
DISCOVERIES ABOUT SHORT WAVES IN DAYLIGHT

I THEREFORE resolved to make further experiments between Poldhu and the *Electra,* to see if some means could not be found to overcome the limitation of working hours imposed by daylight. I tried the effect of still further decreasing the wavelength, reducing it to 60, 47, and, finally, to 32 meters and I found that the opaqueness of space in the daytime diminished rapidly as the wavelength decreased. During these tests, which were conducted in August and September of last year, the 92-meter wave could not be heard for many hours in Madeira—a distance of 1100 miles entirely over the sea. At Beyruth, in the Mediterranean, the 32-meter waves were regularly received all day, although the distance was 2100 miles, practically all over mountainous land.



THE POWER HOUSE AT TRANSRADIO

The most interesting thing in this photograph is the antenna radiation meter which registers up to 1200 amperes. Energy from large radio telegraph stations such as this is radiated in every direction and much of it serves no useful purpose. Senator Marconi believes that beam transmission of radio signals on short waves will do much to alter the whole course of long distance radio communication



© Marconi's Wireless Telegraph Company

A CANADIAN MARCONI TRANSMITTING ANTENNA

Note the high towers in process of erection. Present international stations use wavelengths of from six to seven miles, while the beam transmitting stations will use wavelengths of about 120 feet. POZ at Nauen, Germany is carrying on long distance communication on high power on a wavelength of about 40 meters, while the stations of the Radio Corporation of America are being equipped to use short waves as an auxiliary to their regular long wave equipment. Short wave transmitters do not require nearly the elaborate antenna installation that the present long wave stations do. Senator Marconi contends that reflected short waves are much less subject to unfortunate fading effects than are the long waves

This discovery was so interesting and satisfactory that I thought it wise to confirm it over longer distances and, in October and December of last year, with only 12 kilowatts of power, it was immediately found possible to transmit signals and messages from Poldhu to New York, Rio de Janeiro, and Buenos Aires when the whole of the track separating these places from Poldhu was exposed to daylight. Poldhu was also able to communicate with Sydney, in Australia, for a period of 23½ hours out of 24.

To sum up my impressions of all these experiments, I can say that I am now firmly convinced that the day is fast approaching when beam stations, using short waves, and employing only a fraction of the power utilized in the present high-power stations, and with much lower and fewer masts, will be able to carry on communication at practically any time between any two points of the earth's surface and at much higher speeds than are now possible. It should be mentioned here that very high speeds appear to be possible only with short waves and, therefore, even if only a portion of the 24 hours were utilized, a much greater number of words could be transmitted than would be possible with a slow-speed, long-wave service, even should it be found capable of working during the whole of the 24 hours. It should also be borne in mind that, although communication at great distances has been obtained without the use of reflectors, still I am of the opinion that these will be found to be essential for the carrying on of commercial, high-speed services, because, apart from their directive effects, they enormously increase the effective strength of the signals, thus minimizing the effects of what is known as "fading." Reflectors, I find, also increase the margin of readability of the signals.

WE DON'T KNOW MUCH ABOUT THE LAWS OF SHORT WAVES

NATURALLY a good deal remains to be done in connection with a further and still more systematic study of these short waves and the conditions and laws which regulate their propagation through space. For some time, the practical technical side of radio has been far in advance of the theory of the subject. We have known a great deal about the methods of producing electric waves and about the various methods of receiving such waves, but our knowledge of the conditions that govern their propagation through space is far from exact. Otherwise, as I have said, we might have known long ago that it was possible to send messages to Australia throughout the 24 hours on a 30-meter wave with only 10 or 12 h. p. of energy in the antenna.

However, now that this has been ascertained and confirmed by numerous experiments, I have no doubt that the development of short-wave beam stations will be more rapid than that of the old super-power stations, and it is my firm personal opinion that these latter will, sooner or later, be found to be uneconomical and comparatively inefficient so far as long-distance commercial communication is concerned.

One final point remains to be mentioned in connection with these newly discovered properties of short electric waves. We may be on the threshold of a day when broadcasting, that application of radio which interests the whole of the civilized world, will have its range enormously increased. Within a year

or two, the voice of the King of England, for example, may be easily and clearly heard by millions of his subjects in places as far apart as India, Australia, Canada, and South Africa. A service in Westminster Abbey, with its sermon, choral and organ music, may be clearly heard in Capetown. It may become as easy to listen-in for the Philharmonic Orchestra in London, as it would be now in Philadelphia.

Perhaps the voice of the short wave will be able to accomplish for human brotherhood and our common civilization what has not yet been done by the better-known long wave, although radio is already one of the most powerful agents in the linking of mankind into one great whole.

MASTS AT THE CARNARVON, WALES STATION

Of Marconi's Wireless Telegraph Company. These tall masts help to conduct the high power long wave radio telegraph signals into the ether. Compare the size of the power pole with that of the radio masts. This transmitter spreads its energy in practically every direction while the beam station, illustrated below, directs its energy in a beam

© Marconi's Wireless Telegraph Company

HOW THE POLDHU BEAM STATION WILL LOOK

High towers support the reflecting antenna while the very short sending antenna is in the exact center of the whole structure. The English Marconi Company recently announced that it planned to erect beam transmitting stations which will link England with all her colonies. The English Company expects to establish surer and more efficient communication, using the methods developed by Senator Marconi, which may, perhaps, replace the extensive installations now necessary for radio telegraph communication over very long distances

INSIDE THE CRATER OF MT. VESUVIUS

Professor Rogotti of Milan, with two assistants, transported a radio receiver inside the crater of this famous old volcano to test the radio receiving qualities of this somewhat sparcely populated area. The tests seem to prove that there was no radio reception near the eruptive cone of the volcano, while at a distance of 300 feet from the cone, reception was rather poor. The experimenters, as the photograph shows, wore masks as a protection against the stifling gases from the erupting cone

THE MARCH OF RADIO

By J. H. Morecroft

Past President, Institute of Radio Engineers

How the Propagandists Work in Radio

UNDOUBTEDLY there are millions of people in the United States to-day who have a real interest in radio broadcasting. Discounting many times (as any sensible person unconsciously does) the figures given out by over-enthusiastic broadcasting managers, we still must place the number of these radio folk at some millions.

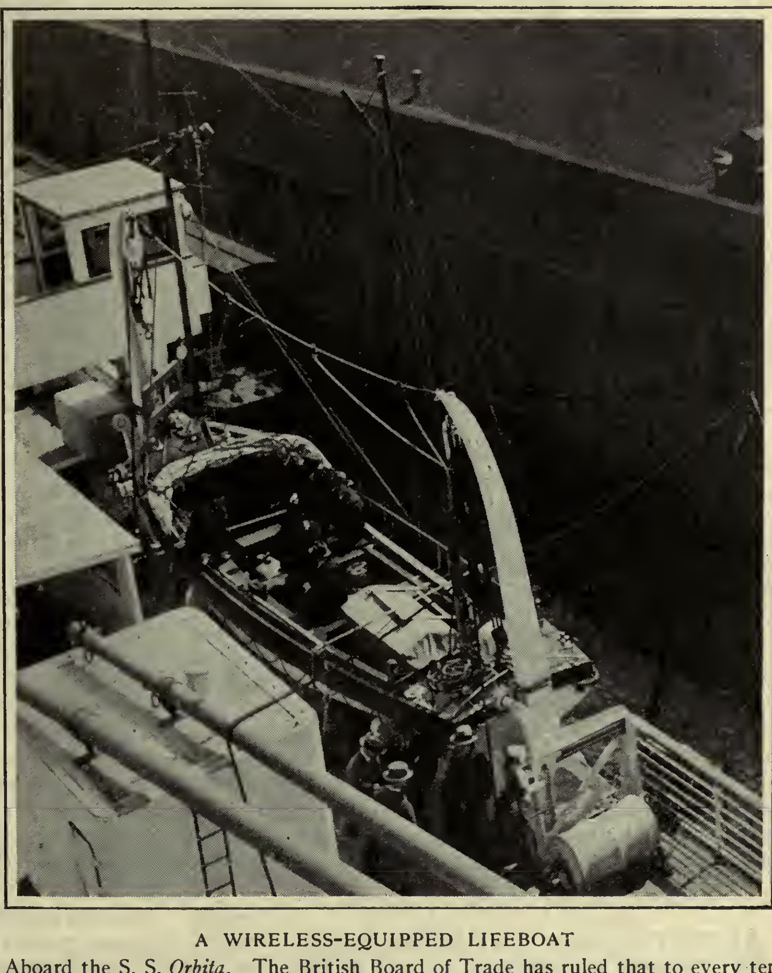
The purchasing power of such a number of people is tremendous, and is measured, of course, in the hundreds of millions of dollars. It is natural that some of the radio manufac-

turers have reached the conclusion that the employment of professional propagandists—"public relations counsel" is a kinder phrase—would be greatly to their advantage. These gentlemen, honorable, no doubt, draw their pay for creating in the minds of the public a favorable impression for the man or product they write about. Stories at regular intervals come from these rather undesirable publicists in which their employers are favorably featured. These stories frequently find their way into the daily press and so appear as unbiased news to the casual reader.

By sheer repetition, one is frequently convinced that the repeated statement is fact, even though no proof has been given. This is illustrated by the current belief that four people out of five have a certain malady, whereas the prevalence of this trouble is undoubtedly greatly exaggerated in the well known advertisements. If one reads enough stories, each beginning with, Mr. A. B. C., the well-known radio engineer and inventor, one is quite likely to think that the man in question *is* a radio engineer and inventor, when that may not be the case at all. Then if the story gives Mr. A. B. C.'s ideas on a certain radio subject one is likely to think that an authoritative, unbiased opinion is being presented, when as a matter of fact, the gentleman in question is simply succeeding in a bit of indirect advertising.

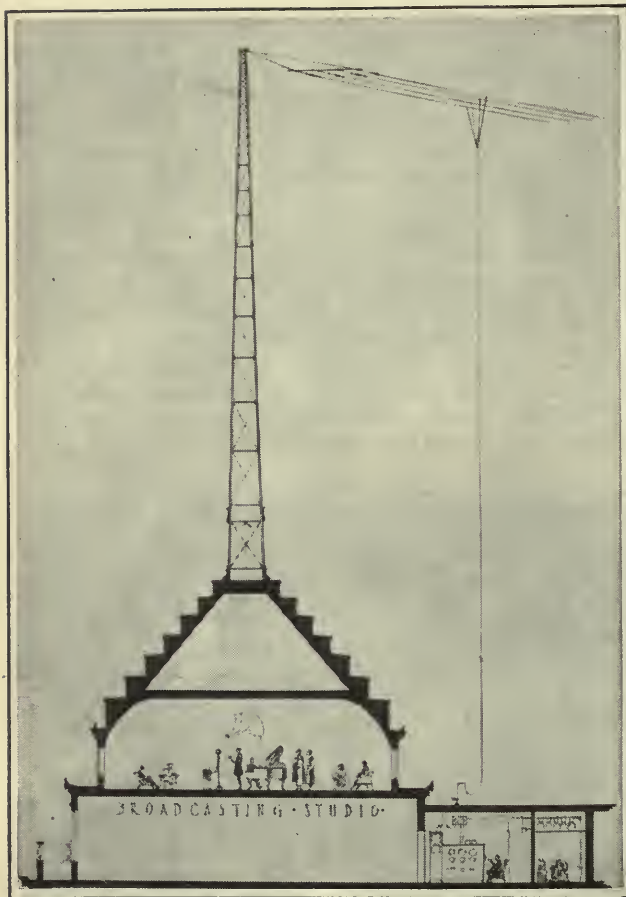
So prolific are the writers of this type that the radio editors of our newspapers never lack material with which to fill their daily columns. One of our friends recently offered to write for a certain paper a series of popular articles dealing with the relative merits of different receivers on the market, showing how they worked, why one was more selective than the other, another good only for local reception and still another preferable for distant stations, etc. He was told by the radio editor, however, that instead of paying for radio articles, he had quite a task in selecting his stories from material which was sent in voluntarily.

To the best of our knowledge, there are very few men writing stories (even radio ones) to-day for the mere love of writing. We should like to suggest that when next you read



A WIRELESS-EQUIPPED LIFEBOAT

Aboard the S. S. *Orbita*. The British Board of Trade has ruled that to every ten lifeboats aboard large passenger ships, there shall be one lifeboat with radio transmitting and receiving equipment. The operator has a small cabin 'way up fo'ard. The transmitter has a range of about 100 miles. A small two-wire antenna is used. In the bow of the boat is the rectangular loop used in the direction-finder equipment



ARCHITECT'S DRAWING OF A PROPOSED BUFFALO STATION

Which incorporates some new ideas in station design. The towers rise 60 feet above their pyramidal pedestals, whose design was suggested by a pyramid built in Guatemala many thousands of years old. The broadcasting station has been designed especially for the new Liberty National Bank building at Buffalo. Alfred C. Bossom, of New York is the architect

one of those interesting interviews with "Mr. A. B. C. the well-known radio engineer and inventor," you ask yourself first whether he really is such a well-known engineer and next why he said that a crystal was better for a detector than a tube, etc. Just possibly his revenues will be increased if you direct your purchases along the line he suggests.

Super Power Is Almost Here

ALMOST as soon as this magazine appears, the new broadcasting venture of the Radio Corporation will be launched. At Bound Brook, New Jersey, the Corporation has erected its first high-powered broadcasting station, and we understand that, opening some time in June with a moderate power output, this station will gradually increase its power until its full output of forty to fifty kilowatts is reached. Familiar WJZ, which was first berthed in Newark, New Jersey and was later transferred to the heart of New York City, is now to migrate to Bound Brook, the while with greatly increased output.

It is our belief that the operation of high-powered stations such as this, is one of the real solutions for static. This ever-present disturbance does not greatly bother those of us who are within perhaps twenty-five miles of a low-powered station, but for those more than a hundred miles away from one of our present 500-watt stations, the pulses of static are at least as strong as the signal during parts of the year. During a few of the summer months, the static noises are so loud that they make a program from the distant station unsatisfactory.

As the various static eliminators come forward and then quietly retire from the radio stage, we can find no evidence of defeat or even fatigue in our atmospheric disturbances. The only evident remedy to circumvent nature in her pernicious interference is to greatly increase the strength of the radio signals, to drown out static. That will require a great many kilowatts of power, as WJZ anticipates using. We shall all watch with great interest the public's reaction to the new venture.

Again it is to be pointed out that those radio listeners near the high-powered station will naturally have some difficulty in tuning it out sufficiently well to hear distant stations of nearly the same wavelength. This tuning difficulty will be true of the average set as used to-day. It will be possible, however, to build special rejector circuits which will greatly cut down the WJZ signals even for those in its immediate vicinity. Undoubtedly a rejector circuit for a reasonable price will be put on the market.

The Crime of a Radio Manufacturer

JUST as we had thought the single-circuit regenerative receiver was beginning to disappear from the market we learn from a most reliable source that an order for about one hundred thousand of these receivers is being put through the shops of one of the largest radio manufacturers. One hundred thousand more potential squealers from one manufacturer is a frightful stop to radio progress. This is no step forward in the march of radio. It looks as though this manufacturer was more interested in dividends than in the advancement of the art.

What Is a "Bootleg" Tube?

AS ONE after another of the vacuum tube patents expire, it becomes increasingly difficult to say just what is a bootleg tube and what isn't. While Fleming's valve patent and De Forest's three-electrode patent were still running their seventeen-year life, it was an easy matter to distinguish between genuine and counterfeit tubes. But now with the fundamental three-electrode idea thrown open to all, (the patent expired in February) one has to look more carefully to see if a tube is infringing those design patents and others which still have some time to run.

Before a manufacturer invests much money in the business of tube making, he would do well to consult some patent attorney who is closely in touch with this particular field. There are many patents on the details of construction which may still be infringed. The sensitized tungsten which is used in the modern tube is a patented product. It is probably not possible for any manufacturer but the Radio Corporation to make tubes whose filaments are made electronically active by the addition of thorium. There may be other ways of making even better tungsten. It seems quite possible that European tubes are made sensitive by some other process, and if so, such a process may become available to independent manufacturers here. Schemes used for attaining this high vacuum are fully patented. The difficulties of properly exhausting tubes frequently are so great as to cause the downfall of the inexperienced manufacturer. There is one very interesting phase of the tube situation which has still to be settled. Years ago, the American Telephone and Telegraph Company and the General Electric Company were involved in a very seriously contested suit having to do with the question of degree

LIEUTENANTS McCORMICK AND FLOOD

United States Army, looking over their receiving apparatus which was of considerable aid during the recent national balloon elimination race. The race was won by Ward T. Van Orman. Broadcasting stations near the air course broadcast special weather instructions and metereological information to the racers

of vacuum used in triodes. Doctor De Forest, several times, apparently, had admitted the advantage of some gas in his audions so that the question of a tube having very high vacuum was still unsettled. Doctors Langmuir, of the General Electric Company, and Arnold, of the Western Electric Company, both had patent applications for high vacuum tubes whose vacuum was so high that whatever gas was present played no important rôle in the functioning of the tube, as it generally did in the De Forest audion. Most extensive testimony was taken and intricate experiments were performed before the court to illustrate the effect of small amounts of various gases in vacuum tubes.

On a case like this, a judge has a hard time in reaching a reasonable decision, and in this case no decision at all has yet been reached. The court has first to determine whether a high vacuum of this sort is patentable, and then if it is, to whom the patent should issue. And this question of high vacuum is not as easy as one might think. The "gas" tube, for example, might be claimed as high vacuum because there is only about one hundred millionth of the original amount of gas left in the tube. But the high vacuum expert comes along and tells the judge that although only one hundred millionth of the original gas is left in the tube there are still ten thousand million gas molecules per cubic centimeter left in the tube! In such a dilemma, what was the judge to conclude?

This high vacuum patent, if it should ever be granted, would most seriously affect the independent manufacturer. In fact, should the court decide to grant a patent of this kind for seventeen more years, the Radio Corporation or the American Telephone and Telegraph Company would completely control the tube situation. We regard that control as lamentable because we still remember the $6 we used to give for Radio Corporation tubes until the De Forest patent was about to expire when bootleg tubes appeared more plentifully with the resultant cut in selling price of 3 to 1.

AT WELLESLEY COLLEGE

Wellesley, Massachusetts, some of the advanced students in the Physics Department are learning something about radio. Left to right: Miss Lucy Begeman and Miss Louise McDowell, instructors of radio in the Physics department of the College; Miss Truko Nakamura, Tokyo, Japan; Miss Jane Whigham, Pittsburgh; and Miss Ruth Lovejoy, Boston. The essentials of a fifty-watt continuous wave transmitter are being assembled

K. INUKAI
Japanese Minister of Communications, listening to a Tokio radio program with members of his family

Radio Sets Must Meet the Claims Made for Them

A MOST commendable decision was recently handed down by Judge Woester in the Municipal Court of Cincinnati. A radio supply house had sold a five-tube set with the guarantee that it would "get" all the stations from coast to coast. The user claimed that the set did not bring in every broadcaster and he refused to pay for it and was subsequently sued.

The Judge ruled that if the set was guaranteed to do certain things it must live up to its guarantee. If the claims were not met, the purchaser was not obliged to pay the price specified. It was argued that the purchaser didn't have a good ground or antenna; the plaintiff evaded the obvious confession, that his claims for the operation of the set were extravagant. It would be a good thing to have a few more decisions of this nature on record. We think that then dealers and salesmen might be more careful about their enthusiasms. It may be that the ruling of the Municipal judge will be reversed when the case is carried to the higher courts, but we hope not. Absurd and extravagant claims of radio salesmen have far too often resulted in the disappointment of the purchaser.

The Associated Press Recognizes Broadcasting

DURING the recent annual meeting of the Associated Press in New York this conservative organization yielded to the pressure of the modernists within its ranks and decided to make radio broadcasting one of its many allies. The great national interest in the broadcasting of the last presidential election was the lever used to upset the conservatives. By a vote of 130 to 10, the Association decided to permit its dispatches to be used over radio channels when the items can be regarded as of "transcendent importance."

The resolution which admits radio as a friendly arm of the Association was as follows:

Whereas, the tremendous and continuing growth of radio broadcasting is presenting many new problems not contemplated when the existing by-laws and rules of The Associated Press were adopted; and

Whereas, the great public interest in the result of Presidential elections and other events of nationwide importance has repeatedly raised the question of the advisability and wisdom of permitting the limited and restricted use of Associated Press matter in the broadcasting of such special and outstanding events; therefore be it

Resolved, That the Board of Directors be authorized to adopt the necessary rules and regulations

which shall permit the broadcast of such news of the Association as it shall deem of transcendent national and international importance and which cannot by its very nature be exclusive, provide adequate safeguards, and require that proper credit in each and every instance be accorded the Associated Press.

The great activity of the Associated Press, with its 1195 newspaper members, is indicated by the treasurer's report which showed an income during the past year of more than seven million dollars.

At about the time that the "A. P." was taking this action on radio, the American News paper Publishers' Association was also taking cognizance of this newest method of communication, endeavoring to eliminate propaganda and direct advertising from the radio channels conducted by the newspapers. The resolution passed by the publishers was as follows:

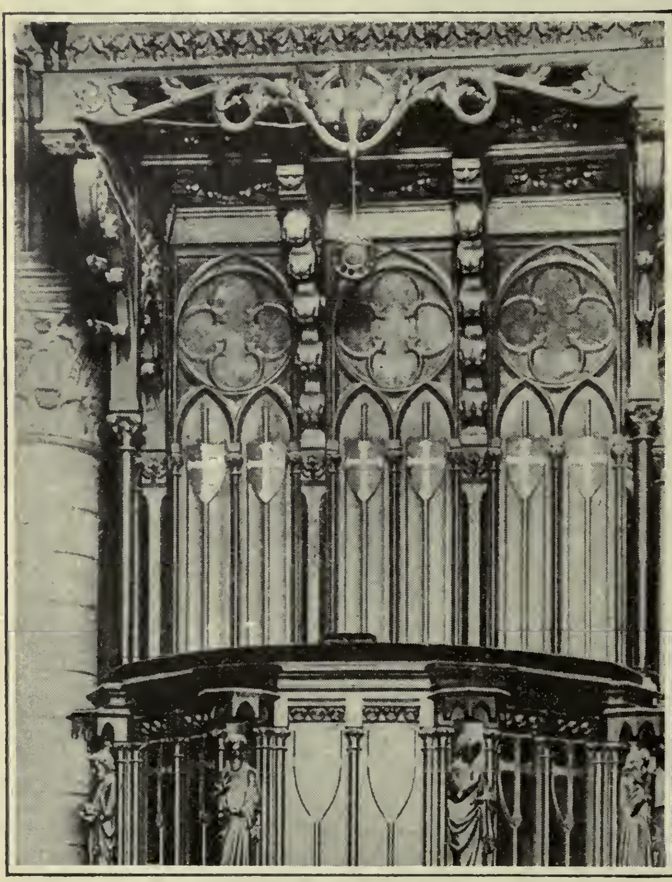
Whereas, direct advertising by radio is likely to destroy the entertainment and educational value of broadcasting and result in the loss of the good-will of the public, therefore be it

Resolved, that members of the A. N. P. A. refuse to publish free publicity in their news columns concerning programs consisting of direct advertising; also that they eliminate from program announcements the name of trade-marked merchandise or known products obviously used for advertising, and that newspaper broadcasters eliminate all talks which are broadcast for direct advertising purpose.

The Victor Company Joins the Radio Ranks

THE phonograph companies have, one by one, yielded to radio. The recent annual report of Eldridge P. Johnson, president of the Victor Talking Machine Company, announces the future radio activities of this company. "Plans carefully and deliberately developed toward meeting the conditions confronting the industry are rapidly nearing maturity, and are anticipated to maintain your company in its position in the van of the entertainment field." These "conditions" of course, are the effects of the popularity of radio receivers on the sales of talking machines. We may expect the Victor organization to make an excellent impression on the public when they do enter the radio field. The wonderful entertainment their artists gave us last winter through WEAF, and other stations, would permit nothing else.

There is a fine opportunity for the marketing of an artistic high quality loud speaker. Rumor has it that the Victor Company has secured the patent rights to a loud speaker developed and patented in France. Some European engineers have spoken of this talker as better than anything we have in America, and if this is true, we certainly



SCIENCE INVADES THE CHURCH

The microphone an excellent symbol of modern progress suspended over the famous carved pulpit of Notre Dame de Paris. The pulpit was designed by Viollet-le-Duc. The microphone is not for broadcasting but for the public address system which has just been installed in this famous old cathedral

would like to see it put on the market here.

We sincerely hope that the new policy of the company will not interfere with continued concerts by their artists, as it is impossible at this time to imagine a better combination than the artistic talent of the Victor performers and the technical excellence of the broadcasting apparatus of the American Telephone and Telegraph Company engineers.

There Are So Few American Radio Tubes

IN A recent issue of the *Wireless World* (London), editorial dissatisfaction is expressed with the number of tubes now on the English market. So many experimental and war type tubes as well as more standard recent ones are available to the radio experimenter, that many times he buys tubes entirely unsuitable for his work. Improvement would be brought about, according to Hugh S. Pocock, the editor, if most of the types were withdrawn from the market, leaving only two or three standard types.

If we in America have any difficulty of this sort, it is rather on the opposite side. We really have only two types of tubes for receivers on the market; the quarter-ampere 5-volt filament, and the sixteenth-ampere 3-volt filament. The latter is hardly to be regarded as a success because of its fragility and short life. In Holland, a Dutch engineer recently told us, the Phillips Lamp Works is putting on the market a tube which he regards as the equal, if not the superior, to any of our tubes. The Dutch tube uses in its filament circuit a sixteenth of an ampere at one volt. that is, just one third the power which ours uses. We would welcome this Dutch tube to our present small assortment. The tube which uses alternating current in its filament and operates from a light socket, is surely on its way. The so-called McCullough A C tube built on this principle, has recently been announced and just as sure as the public takes to this tube, the Radio Corporation will put out one to equal or possibly surpass it.

We sincerely hope that the McCullough tube has been so carefully built that it will not fail, and thus give this desirable type of tube a bad reputation before it has been even well tried out. In a new development of this kind it is very easy to make technical and manufacturing errors, and so give a product a bad name when more care and study would have made it a complete success. We certainly extend to this first alternating current tube our very best wishes.

©Harris & Ewing

W. E. DOWNEY

Technical radio expert of the Bureau of Navigation, Department of Commerce. On Mr. Downey's shoulders fall much of the technical advisory work which is a constant necessity in the administrative branch of government radio control

The World Conference of Amateurs

THE first world conference of amateurs has just come to a close. And thinking of this world union, the amateurs may well feel that progress is being made. Ten years ago, the American Radio Relay League was just starting; now its members are numbered in many thousands and they assume a commanding rôle in any international question having to do with radio amateurs.

The conference recommended wavelength assignments for the amateur channels as follows: United States, 85 to 70 meters and 41.50 to 37.50; Canada and Newfoundland, 120 to 115 and 43 to 41.50; Europe, 115 to 95, 75 to 70, and 57 to 43; other countries, 95 to 85 and 37.50 to 35. These short wave channels, of course, must be approved by the respective governments concerned before becoming the official domain of the amateurs.

It is interesting to note how important the short wave channels are becoming. American British, and German commercial companies are all carrying on intensive experimentation in the development of transmitters and receivers for these nearly ten million-cycle currents. The German station POZ, for example, is working to Argentine with a 41-meter channel, and it won't be long before the five-

or ten-turn coil, a couple of inches in diameter, becomes recognized as a regular tuning coil.

We cannot urge too strongly that the amateurs get busy with their short wave receivers. As this issue goes to press, Donald MacMillan is leaving the country for his next polar trip. In view of the fine showing made by short wave communication on his last trip, Mr. MacMillan has decided that his outfit this time will be short wave equipment altogether, and he has indeed chosen a short wave expert to accompany him, in John L. Reinartz of South Manchester, Connecticut.

Plans for the expedition include the transmission of a daily *resumé* of their activities and findings, sent out at noon on a 20-meter wave. Recent successful daylight transmission with these extremely high frequency currents lead to the belief that the signals will be picked up at Washington where the government services will be listening, and thus permit a rebroadcast on ordinary wavelengths.

Work for Hoover's Third Radio Conference

SECRETARY HOOVER is again contemplating calling in the best radio minds in the country for a third annual conference.

The possibility of such a call was considered by the conference of the Radio Committee of the League of Nations which has been in session in Geneva. It was anticipated in Geneva that the Washington call would not come until the spring of 1926 at the earliest. This committee decided to call to the attention of the Washington conference the necessity of elaborating the international regulation of radio communication concerning security at sea and the protection of navigation. It has not been apparent that commercial radio has seriously interfered with the channels reserved for navigation and distress messages, but it may be that the problem in European waters is more serious. If this is so, the Washington Conference would do well to consider it.

The Month in Radio

IN GERMANY it is a crime to listen-in on broadcast programs unless the government fee has been paid, and according to a press dispatch, there are more than 550,000 obedient citizens who pay the Post Office Department about fifty cents a month for their radio entertainment. At present the government receives more than three million dollars annually from the radio enthusiasts.

MORE than three years ago, in fact in our very first editorial, we suggested that philanthropists should leave money for equipping and endowing high class broadcasting stations. This movement had its inception at the University of Notre Dame and the University of Illinois, both of which are to be given modern stations as memorials to Roger C. Sullivan, a well-known Democratic leader of Illinois who died five years ago. The stations are gifts from his son, B. H. Sullivan. This is a fine beginning of a worth-while enterprise.

THE Radio Corporation's quarterly report shows its gross earnings for the quarter ending March 31st to be more than $15,000,000. This indicates a total for the present year at the same rate of $61,000,000 or about $6,000,000 in excess of last year's business.

LAST month saw the exportation of some of America's good radio capital. Dr. Marius Latour, a French scientist, owns many patents on details of radio receivers, some of which have been used promiscuously by American radio concerns, who were apparently all oblivious of his patents. In a suit which he brought against the Hazeltine Corporation, Latour was successful in sustaining his claims, so this radio company, and several others decided to capitulate and buy him out. One of his patents covers the use of iron cores in radio transformers. No sensible engineer ever thought of using anything but iron cores insofar as we know, yet Latour was able to get a patent on the idea. Most of his other patents are of similar import, but, lacking as they may be in scientific merit, they were sufficiently important to cause our American companies to part with several hundred thousand dollars.

ACCORDING to newspaper stories, the General Electric Company recently demonstrated the operation of a loud speaker from a crystal set. From the layman-writer's description it appears that the instrument is a cross between the large paper cone speaker and a French type using a small, flexibly supported, rigid cone. Needless to say a crystal set must be very close to a transmitting station if a loud speaker is to be operated by it, because at any appreciable distance, the receiv-

ing antenna cannot pick up enough power to give audible sounds in any loud speaker. With tube sets, the local B battery gives the energy to operate the loud speaker. The received signal merely serves to control this energy.

SOME interesting figures on the income of broadcasting stations were given out recently by the Radio Artists' Association. According to their report, some stations are actually making money. WHN of New York, for example, has a reputed income of $300,000 a year and expenditures of not more than $50,000 a year. WFBH in the same city, has contracts which bring in $90,000 a year with an annual expenditure of $35,000, it is reported.

The stations in present Telephone Company network charge as follows:

WEAF $500 per hour, $195.35 per quarter hour; WEEI, WJAR, and WCCO $250 each per hour; WOO, WFI, WCAE, WGR, WSAI, and WWJ $200 each per hour; WCAP, WEAR, and WOC $150 each per hour. For the "facilities" of all these stations, the gross charge is $2600 per hour. To give a ten minute talk over this wire-radio network would cost $1300, or about a dollar per word.

The manager of WHN, when shown the report characterized it as a gross misstatement, and similarly, WFBH's manager claimed that his income was only just sufficient to meet expenses.

Interesting Things Interestingly Said

DAVID SARNOFF (New York; vice-president and general manager of the Radio Corporation of America): "At present it cannot be said that advertising over the radio is parallel in effectiveness with advertising in periodicals and newspapers. The standards of periodical and newspaper advertising should also apply to the standards of the air and no advertisement should be broadcast without the plain advertising label."

HARRY M. WARNER (New York; president, Warner Brothers, a motion picture company): "My attention has long been directed to a general tendency to fight radio within the amusement field. The identical arguments used only a few years ago in an effort to minimize the popularity of motion pictures are being dragged out and pointed at an entertainment which now, roughly, has 20,000,000 supporters in the United States. . . . The cry of 'the pictures will ruin the theatre,' is within easy memory. But they didn't, although there is no doubt that the pictures inflicted considerable damage to the cheaper theatrical attractions. . . . To this has been added the alarm, 'the radio will ruin the theatre and pictures.' It will not, provided it is used intelligently. . . . The radio is here to stay just as the theatres and pictures are here to stay. They all have their followers, and just as the picture audience is a theatre audience, so is the radio audience largely a picture audience. . . . To my mind, any effort to fight an entertainment that

POWEL CROSLEY, JR.

Cincinnati; Radio Manufacturer

"I am looking forward to the day when first class broadcasting stations will use from 50 to 100 kilowatts. I believe that this is as essential as it was for the commercial companies figuratively to boost the power of the original ½ kilowatt used by Marconi when he sent the famous letter "s" across the Atlantic Ocean to 50 kilowatts and later, to 200 kilowatts, for satisfactory transoceanic communication. The high power broadcasting stations of the future must be located away from large centers of population so as not to cause undue local interference.

"The quality of service rendered by the higher powered stations should be recognized by the Department of Commerce in assignment of wavelengths, and this recognition should necessarily have coupled with it, certain requirements as to quality of service. . . . There must be more recognition of quality of service and priority than there has been heretofore. First class stations should not be asked to divide time with third class ones. . . . Though still untried, I believe more strongly than ever in super-power"

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CAPTAIN A. W. STEVENS

New York; Aerial Photographer with the Rice Expedition in Brazil

"Although we worked with portable radio apparatus in the heart of the world's greatest forest, we established a record in short-wave communication with England. Long-wave communication was carried on between the expedition and Manaos and short-wave communication to many parts of the world, including New York, San Francisco, London, Rio de Janeiro, and New Zealand. The signals were reported as very strong, both in New York and London. Part of the apparatus was designed and assembled on the job by the operators, John W. Swanson and Thomas M. McCaleb.

"The antenna system was often erected by sawing down a number of large trees in the forest and stringing the wires between other tall trees on the edges of the roughly cleared space. A wire was usually strung from the folding table that held the instruments to a ground loop."

has the backing of 20,000,000 people is sadly misdirected and will react harmfully on the entire industry. If radio has had an effect on motion pictures—as those exhibitors who should know what they are talking about claim—my idea is not to wage a useless fight against it, but to use radio to the best possible advantage."

N. P. VINCER-MINTER (London, England; in an article in the *Wireless World*): "From a point of view of artistic appearance, American-made radio sets show a marked superiority over those made in England. In this respect we are not referring to the hundred-guinea type of cabinet set, whose artistry cannot, of course, be denied, but to the ordinary type of good quality set which sells at prices ranging from £20 to £40 or thereabouts. . . . One has only to glance through the advertisement pages of any of the American radio journals to note the large number of really efficient and attractive-looking sets at not unreasonable prices, to be acutely aware of how much greater is the range of choice accorded to American purchasers. Although, of course, some of the claims made in these advertisements are typically American, it must be admitted that on the whole the sets are highly efficient."

BRUCE J. A. M. ELDER (Sydney, Australia; Commissioner for Australia in the United States): "Production costs have increased enormously, until now wages in the tailoring trade are 300 per cent. above the pre-war level. Factory expenses have also doubled. . . . But there are other factors equally important. In the United States, there are more than 17,000,000 motor cars, which exceeds the number of telephones. These cars are bought on time payment as are also the majority of wireless sets in the country. I am of the opinion that the purchasers of cars and radio sets meet obligations by saving on clothing for themselves, their wives and families. Radio causes people to stay in their homes, thus lessening the demand for clothing. American bankers go further and say that people do not wear good clothes in motor cars and consequently purchase new clothes less frequently."

EDWARD H. JEWETT (Detroit, Michigan; president of the Jewett Radio and Phonograph Company): "Time was when open cars were all the rage and most autoists stored their cars during the winter. . . . Radio has developed similarly. From a purely winter instrument it has been brought to the point in development—thanks to the fine engineering talent in the radio industry—where it affords the radio enthusiast a full year's pleasure and utility. . . . Mighty few vacationists will be without their radio this summer. Modern portable sets are as easily taken along on a summer journey as the ordinary suitcase. The summer camper may pick the wildest, loneliest spot for his vacation and yet be in touch with the world through his radio."

S. H. MAPES (Chicago, Illinois; vice-president and general sales manager, Joseph W. Jones Radio Manufacturing Company): "Is the possibility of extensive improvements in radio sets affecting sales? The answer is an emphatic no. For the improvements that will come will be those of 'evolution rather than revolution.' . . . Radical changes will not be made, but refinements will continue to appear as they have in the automobile and other industries. The more noticeable changes will be made in transmitting and not in receiving sets."

The Listeners' Point of View

JENNIE IRENE MIX, who has written "The Listeners' Point of View" since April, 1924, died suddenly after a short illness at her home in Toledo, Ohio on April 26th.

When "The Listeners' Point of View" started it was the first attempt to present sound radio program criticism in any magazine. Miss Mix was probably better qualified than any other writer who could have been selected for the task. For many years she had been writing music, thinking music, and almost living it. She was well known in the musical life of Pittsburgh. From 1904 to 1918 she was music critic of the Pittsburgh *Post*. During many music seasons she covered important musical events in Boston, Philadelphia, Cincinnati, Cleveland, Ann Arbor, and Chicago.

Miss Mix spent some time abroad, where she furnished music correspondence to a number of prominent American newspapers from such centers as Paris, Berlin, Munich, Dresden, and Bayreuth. In 1920, Henry Holt and Company published a novel from her pen, *At Fame's Gateway*, which deals with the life of a young music student in New York. Comment on this book was very favorable and very widespread. Several years before, Miss Mix had turned her talents in another way and *Mighty Animals*, published by the American Book Company, presented in an entirely new fashion the story of prehistoric animals. The preface to this volume was written by Dr. Frederick A. Lucas, director of the American Museum of Natural History. The book is used as a supplementary reader in public and private schools.

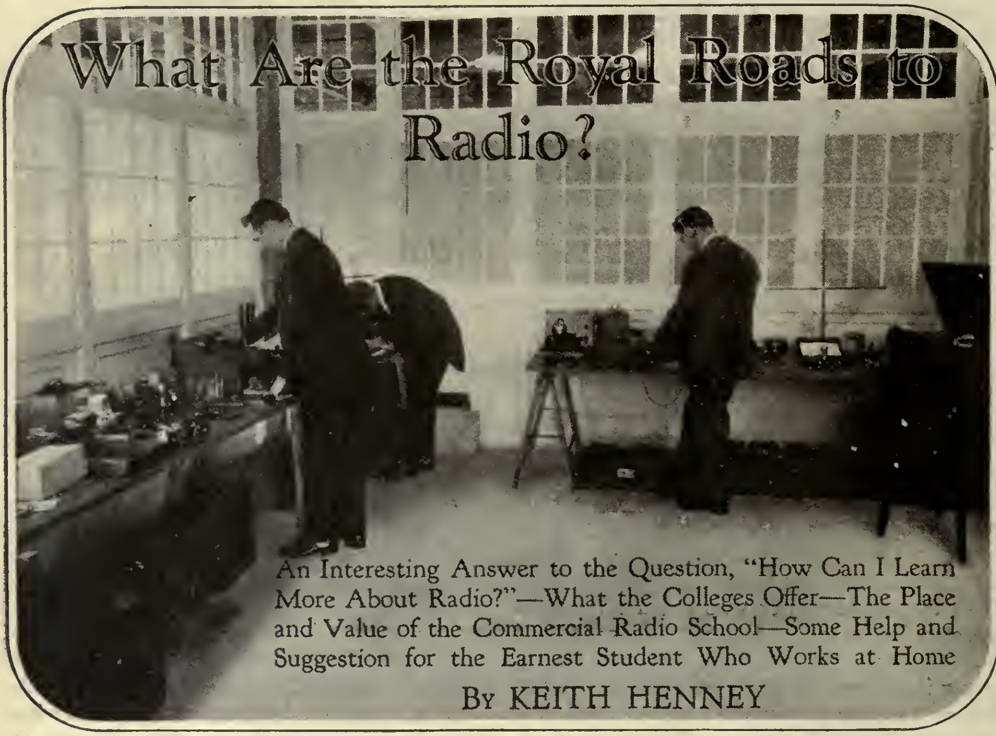
A woman of striking personality, Miss Mix had a peculiar talent for transferring her personal charm to her work, which was one reason for her great popularity with the readers of RADIO BROADCAST. It is interesting to note, also that, in the newspapers, her writings were almost as widely quoted as those of Professor Morecroft in "the March of Radio."

Miss Mix felt that, since the greater part of radio broadcasting was music, helpful criticism and comment about radio music would be welcomed by interested radio readers everywhere. She had a wide acquaintance among musicians throughout the country, and she spent many a musical season in New York covering the events for newspapers in various parts of the country. In "The Listeners' Point of View," she was singularly successful in presenting comments about radio broadcasting programs which could be found nowhere else. Her remarks on programs and personalities, her news and comment on the new world of radio, made for her and for RADIO BROADCAST many firm friends.

Jennie Irene Mix
April 26, 1925

The Listener's Point of View will be continued in the magazine as before, and the new conductor of the department will take up Miss Mix's duties in the August number of RADIO BROADCAST.

What Are the Royal Roads to Radio?



An Interesting Answer to the Question, "How Can I Learn More About Radio?"—What the Colleges Offer—The Place and Value of the Commercial Radio School—Some Help and Suggestion for the Earnest Student Who Works at Home

By KEITH HENNEY

OF ALL the many questions that come to Radio Broadcast there is one that causes the Editors more than usual thought. The query of "How can I become a radio engineer?" seems to worry a great variety of people. High school students contemplating their college courses, mature engineers, mechanical, electrical, civil, chemical or mining, and professional electricians; all want to know how to fit themselves to enter the radio engineering field. And aside from those who actively plan a dash into the land of radio there are many who would like to know more about this fascinating subject than most of the present day radio books tell them. They are doctors, lawyers, ministers, and the great army of tradespeople who are interested in radio, and who are interested, incidentally, in the whole vast field of science, for its own sake.

And while it is not the purpose of the writer to argue the point here of whether there is or is not a future for a man fitting himself to be a radio engineer, it is well to call attention to two conflicting statements appearing in the press within the last year.

According to Colonel Percy E. Barbour, Editor of *Mining and Metallurgy,* the engineering field is already overcrowded, and he takes exception to the press report that colleges and universities are falling behind in their output of capable engineers.

The other statement may be found in some radio school advertisements wherein the marvellous salary of $10,000 a year appears in large type, and one gets the idea that such a munificent sum may be commanded within a few months after completing some particular course which the school offers.

It is very difficult to judge the truth of the first statement, but it is certainly true that any capable wide-awake engineer may find a position if he has the qualifications mentioned later in this article. The engineering profession, like all other walks of life, needs big men, and this means those who have fitted themselves with all of the modern educational equipment.

As for the $10,000 year salary, it is again largely a question of the man. No student who follows any radio course, whether in college or by correspondence can hope to attain this sum unless he has the most extensive experience behind him. And that entails work, several years of it at least.

WHAT IS A RADIO ENGINEER?

IN THE first place, as Professor Morecroft pointed out in RADIO BROADCAST in July, 1924:

"To the best of our knowledge, none of the good technical schools of this country confer the degree of 'radio engineer.'"

The nearest approach is that given by Harvard University and other large institutions which have a number of courses grouped under the title of "communication engineering" but here, as in other branches of electrical engineering, the first degree given after four years of study is "bachelor of science in engineering."

The degree of electrical engineering "E. E." is usually won only after the bachelor's degree has been taken and after at least two years of commercial experience.

A real radio engineer will probably be proud of the fact that he has had a technical training, but he will hesitate to admit that he is a radio engineer, so thickly populated has the radio profession become with self-labelled authorities without training or experience beyond that of any boy who has assembled radio apparatus.

The field of radio engineering is simply a branch of electrical engineering. A power engineer, a telephone, or a telegraph engineer must first of all be an electrical engineer, and a good one too. In nearly every case, one must have a general engineering training before he can specialize in any of its many branches.

THE STRAIGHT AND NARROW PATH

THE young man who is anxious to fit himself best for the radio world, should learn all he can from elementary books which he can secure in the public library, and from actual experience with radio apparatus. This experience should include both transmitting and receiving apparatus, and here is where the "amateur" has the advantage over his brothers who casually decide to enter the radio world.

It is probable that the greatest number of our future radio authorities will come from the ranks of these so-called amateurs, youths who construct and operate apparatus that enables them to converse with other amateurs across unbelievable distances.

It is surprising what an advantage these amateurs have when they go to college for their further training. They have the "feel" of radio equipment, they are already familiar with laboratory apparatus, and they have acquired first-hand knowledge that gives them a great advantage over their classmates. These relatively inexperienced men who are not so fortunate require some considerable time to gain equal familiarity.

The student should pay as much attention to his mathematics and physics as possible during high school, for all that is learned here will save time in college. If he has time for French in high school, several years of that language will be a great help. Or French and German may be learned in college, and if the student has a fair reading knowledge before his arrival there he will find it a distinct advantage. These two languages have become important adjuncts to an engineer's training, for so much good work is being done on the Continent that a well posted expert must keep in touch with what goes on there. One ought to follow the work of foreign investigators in their own language.

After arrival in college, the student may approach radio from one of two angles, either through the conventional electrical engineering department or through

> ## There Isn't Any Formula—
>
> FOR success in any line of activity. Not very long ago, someone set down three rules for mental progress. They are: "1. Sit down in front of a blank wall. 2. Ask yourself difficult questions. 3. Answer them." And so with radio. The best way to learn more about radio is to learn it. However, there are so many who really want helpful and definite suggestions about how they may improve their radio knowledge, where good college courses in radio are to be had, and what books to read, that it seemed that a helpful discussion of the entire subject would be read with great interest. Boys in high school, preparing for college, want to know what subjects to study so they may progress as fast as possible; older men, out in the whirl of daily existence are eager to know what books will help them to get a good technical foundation in radio theory; and radio salesmen want to learn the technical facts about the merchandise they are selling. This article does not pretend to present complete instructions for success for any of these interested persons. But there is information here which should be of genuine aid. Mr. Henney, who is director of the RADIO BROADCAST Laboratory, is a graduate of Western Reserve, and of Harvard University which granted him the degree of Master of Science. —THE EDITOR

the physics department. For the first year the courses studied will be much the same whether the student is in engineering school or in the "arts" college where he will elect scientific subjects.

A continuation of his higher algebra, trigonometry, analytical geometry and an introduction to the calculus will complete his mathematical background for the more serious work to follow. He will go through the usual Freshman English which is aimed to give him practice in writing. He will continue his foreign languages, and probably learn something of history, sociology, or economics.

In the second college year, the student engineers continue to study more mathematics and they begin to branch out and to concentrate in their various fields. Both the engineers and the physics students learn something of the several branches of physics. Electricity appeals to the embryo radio expert, but he should not forget that acoustics has become a very important part of radio engineering, and his course on sound will prove valuable in his future work.

The third and fourth years are given to more specialized courses. The study of vacuum tubes, and their properties of amplifying, detecting, and oscillating, will be begun, and for the radio enthusiast, this course will prove to be more than interesting as will the study of oscillations and electric waves.

Should all this time and work seem unnecessary to the budding engineer, he should remember that he will be forced to compete with other engineers, and that the better trained will have the better chance of success. The attendance at colleges and technical schools increases each year, and it seems that the youth who passes up a college training without good cause will find himself somewhat handicapped.

THE WIDE SWEEP OF RADIO

RADIO is perhaps the broadest of the various related fields of electricity, for it requires knowledge and practise derived from engineering, from physics, from chemistry, and from mathematics. For this reason, the radio man who is being trained for radio, should have as broad a scientific education as he has time to accumulate.

The radio engineer must know the fundamentals of electricity, and there is no royal road to this knowledge. He must understand the principles of the various branches of physics, such as light, heat, electricity, mechanics, and sound. He must be able to design apparatus that can be made by ordinary machine practices, for a device that cannot be manufactured might as well not be invented, from a practical point of view.

All of these subjects require a knowledge of mathematics, and the more a man is at home with his algebra, and his trigonometry and his calculus, the better is he able to visualize the electrical and mechanical problems that come to him.

At the present time, there are surprisingly few really outstanding radio experts in this country. Among them are college professors whose training and experience has been so extensive—not necessarily in engineering—that they can speak authoritatively on radio theory and radio practises. There are others whose training has not had the formality of any college at all, but they have learned their profession in the more arduous one of experience. It is probable that none of these men hangs out his shingle as a "radio engineer." It is probable that few of them can copy "twenty words a minute" of Continental Morse code.

A real engineer then, is one who understands electricity, who can design apparatus, not merely building it by the cut-and-try method, and who by the aid of his mathematics can arrive at preliminary solutions to important problems without the necessity of long laboratory experiment.

"COMMUNICATION" COURSES

SOME technical schools are recognizing that the field of communication is a distinct entity within the larger one of electrical engineering. As a result, their communication courses include more about vacuum tubes, for example, than about power machinery. Included in such courses is work on telephone lines and their associated apparatus, the methods of signalling under water, telegraph, and, naturally, radio.

"MAN SPECIFICATIONS"

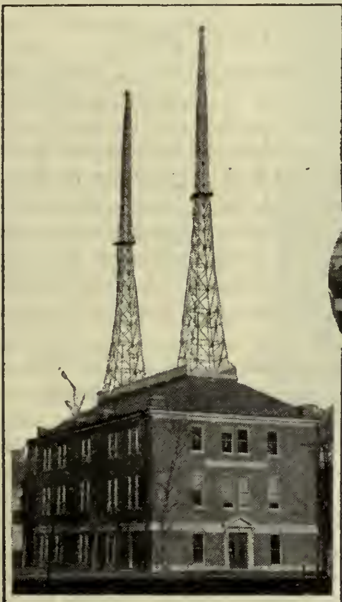
AN INTERESTING statement was made some time ago by John Mills, a prominent educator and engineer who hires the technical men for the Western Electric Company and indirectly men for the American Telephone and Telegraph Company. In this statement he said:

> I look for six characteristics, without regard to the engineering course in which the student has been trained; and I accept for the same opportunity men who as arts college students have had no engineering courses whatever.

In the first place I look for "intellectual curiosity." Unquenched and unquenchable intellectual curiosity is to my mind the first requisite for growth in our rapidly progressing age. The second requisite is the ability to study. It is perhaps the one real aim in education. The percentage of population which has the ability to study is much less than the percentage of degrees and other evidence of learning would indicate. Learning looks to the past, while study looks to the future.

The third requirement is the habit of study.

The three remaining requirements have nothing to do with the content of engineering courses, but they have a great deal to do with the natural characteristics of the student and his general training; they are: first, the ability to learn from men; second, the ability to coöperate with men; third, a promise of the ability to lead men.



—Harvard *Crimson*

CRUFT HIGH TENSION LABORATORY

At Harvard University. This building is one of the few university buildings in the country devoted exclusively to radio work. The oval shows students at work in one of the laboratories. Dr. E. L. Chaffee is standing at the extreme left. Most of the students who are taking work in this building are graudate students, many of them from other universities than Harvard. Professors George W. Pierce, A. E. Kennelly, and Dr. E. L. Chaffee give courses and supervise radio research at the Laboratory

In connection with the first requirement, intellectual curiosity, the writer remembers distinctly a fellow student in freshman chemistry. A young instructor was lecturing at some length upon the simple fact that two molecules of hydrogen and one of oxygen combine to form the well known "H_2O", and this chap wanted to know "how." Such a heretical question apparently astonished the instructor, for he struck up the usual attitude of a young teacher who finds himself in deep water.

But that freshman who was not satisfied by knowing that hydrogen and oxygen did form water, but he was curious to know how, and to-day his intellectual curiosity has got him much farther than his fellows who were not particularly thrilled by the fact that "H_2O" was the chemist's shorthand symbol for one of nature's grandest explosions.

WHAT TRAINING IS VALUABLE

IT IS surprising when one looks over the names of those who appear in the *Who's Who in Engineering* to see the great number of prominent men who have had general college training and who are, technically speaking, not engineers at all. On the other hand one should not forget that President Emeritus Charles W. Eliot of Harvard University was a professor of chemistry, or that Herbert Hoover is a graduate mining engineer.

It seems that aside from the intrinsic value of a technical education, there is much to be said in favor of general training. It is probable that the best-known doctors, lawyers, and educators are those who have studied many subjects not directly related to their particular interest.

Here again it is "intellectual curiosity" and the ability to study that counts, for a man trained in one field may find himself thrust into another. It is probable that the executive engineers who become presidents of corporations are those who have had the widest possible training outside of their narrow technical study.

Benjamin Franklin was "craftsman and

tradesman, philosopher and publicist, statesman, patriot, and diplomat." Yet, too, he was a scientist.

Good radio courses are given by many state universities, and the work that is done at Harvard University under Professors Pierce and Chaffee, at Columbia by Professor Morecroft, and by Professor Hazeltine at Stevens is well known. There are a number of technical schools like Rensselaer or Massachusetts Institute of Technology that give highly specialized work in radio subjects in connection with their departments of electrical engineering.

The student who cannot go to one of these large institutions should not feel discouraged, for any well taught engineering course will give him the background for research or graduate work in radio subjects. It must be remembered that a radio engineer may be a physicist, and there are few colleges that do not have physics departments. The principal thing for the student to remember is to get the fundamentals of electricity and mathematics well in hand; the value of the superstructure of one's training depends entirely upon how well the ground work has been laid.

COMMERCIAL RADIO SCHOOLS

THOSE who are interested in radio and who cannot go to college can learn a great deal about radio. It is probable that the greater number of workers in this fascinating study fall into this class, for they are those who are now working with radio equipment and have neither the time nor the inclination to go through the somewhat lengthy process of becoming thoroughly trained.

The point is that any one can be well posted on radio, and can become well acquainted with radio phenomena at home, or by attending some radio school. Before the day of broadcasting such schools confined their activities to preparing men for the government commercial license examinations. To-day the picture has changed and presents a much broader aspect. Experts are needed for salesmen, for operators, for broadcasting duties, for inspectors in manufacturing plants, and for designers of radio apparatus. Each of these particular positions requires somewhat different training, but the fundamentals of radio should be understood by all. And it is these fundamentals that can be learned at home, or in day or night school, or by correspondence.

The Department of Engineering Extension of Pennsylvania State College gives two courses by correspondence. One of these is an elementary course for those who know little about radio; the other is more technical and complete in its scope and uses as its text, the book *Principles Underlying Radio Communication* prepared by the Bureau of Standards.

These schools draw their students from all walks of life, there are few professions that are not enrolled. A statement from one of the large radio schools is significant:

> An analysis of last year's enrollment showed that 134 distinct and separate professions were represented in our student body, and among them were doctors, lawyers, electrical, mechanical, and civil engineers, postmasters, building contractors, dentists and men of similar occupations.

CHOOSING A RADIO SCHOOL

THE task of choosing a radio school is no simpler than that of choosing a college; there are the same questions to be answered. One should decide what one is to expect from such a school and to find out whether it offers the course that is wanted. Some schools are offering courses in radio research for the advanced student, but there is no reason why the enthusiast cannot perform the experiments included in such a course at home—provided he has the apparatus.

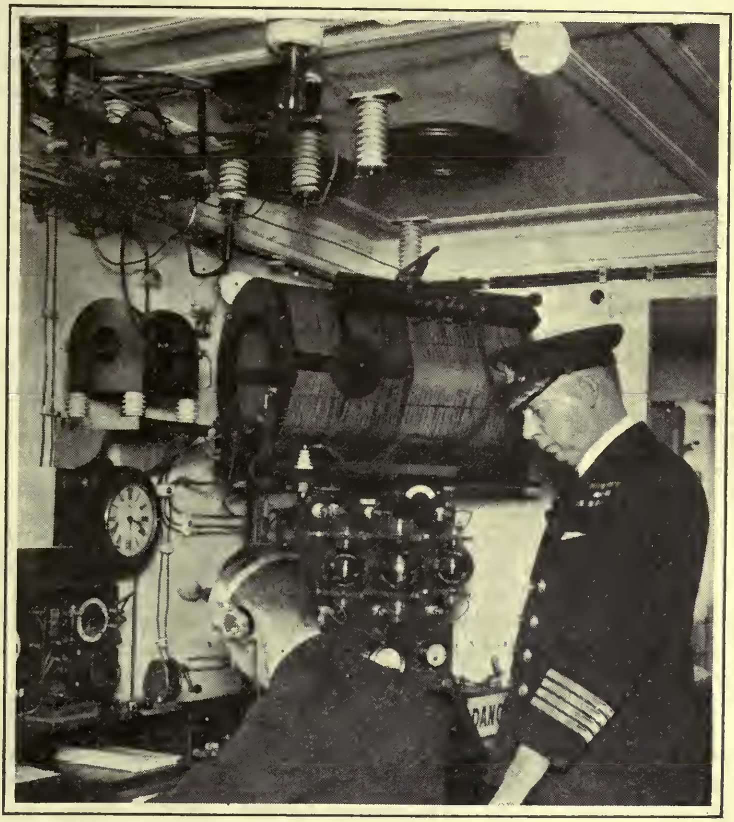
It is surprising how many of the fundamental facts of radio may be discovered by reading and by simple measurements that any radio hobbyist may do. In future issues of RADIO BROADCAST will be found descriptions of apparatus and experiments that will teach much about the characteristics of tubes used as amplifiers, detectors, and generators; of the theories of resonance and tuning; of the effects of resistance in circuits, and of similar work in high frequency alternating current circuits.

Those who have had technical training should get acquainted with their mathematics again, specially the major operations in algebra, trigonometry and calculus. They should master alternating current theory, especially the effect of inductance and capacity in tuning. Technical articles appearing in the radio publications, especially in the *Proceedings of the Institute of Radio Engineers* may be read with much profit. Here are descriptions of modern radio stations, amateur, ship, broadcasting, and high power, complete with technical data and methods of operation. Here, too, are descriptions of new applications of existing apparatus.

The correspondence and day or night schools have much to offer for those who want to know more about radio, and the good that can be done in this direction is incalculable. Radio

is suffering from a lack of first hand information.

The stores that are doing the largest business are those that employ trained radio salesmen, and it seems reasonable to suppose that those that will continue to exist in these days of competition will be those that are best posted on radio facts. The buying public likes to feel that the salesmen know what they are talking about.



A MARINE RADIO OPERATOR AT WORK

Senior operator J. T. Williams, and Captain John Roberts of the S. S. *Homeric*. Part of the tube transmitter is visible. Those who want to gain as much radio experience as possible often spend several years or more as a marine radio operator. Operators, when they are granted their government licenses, are thoroughly examined on their knowledge of radio theory and practise. Practical experience aboard ship is very valuable to the man who wants to have a thorough knowledge of radio. Great numbers of prominent radio men have graduated from the marine operator class to positions of considerable radio success. The amateur radio operator learns much about the fundamentals of radio without leaving his own home. He can gain much from a study of good radio text books and magazines, and more by practical experiments with radio. The study of radio at home, as the author points out in this article, although it cannot substitute for study at a technical school or college, can do much toward building a radio groundwork

RADIO BOOKS

MANY books have appeared on radio since the advent of broadcasting. Some of these appeal to some people, but seem sketchy and stupid to others. It is impossible to recommend a book unless one knows the background of the reader. A book that is too technical for some is too simple for others; and there you are.

Books are a reservoir of knowledge and those that are listed below are not all that have been printed by any means. Two that may be obtained from the Superintendent of Documents, Washington, D. C., should be part of every radio man's library. They are the *Principles Underlying Radio Communication*, which costs one dollar, and the Bureau of Standards *Bulletin No. 74*, which costs sixty cents.

Books written for the laymen are *Radio Communication* by E. W. Stone, *An Outline of Radio* by John V. L. Hogan, and *Dunlap's Radio Manual* by Orrin E. Dunlap, Jr. John Mills' book *Letters of a Radio Engineer to his Son* presents the fundamentals of radio science in an unusual and interesting manner.

Among the more technical books, there are none that are as complete and as useful as Professor Morecroft's *Principles of Radio Communication*. *Thermionic Valves*, by Van der Bijl is useful to the vacuum tube student, but this book is highly technical and was written from the point of view of the telephone engineer. The mathematically inclined reader and those who crave exact proofs of statements will enjoy Professor Pierce's *Electrical Waves and Electrical Oscillations*—which, by the way, contains some excellent material on electric lines and filters, a subject that is treated very sketchily in other publications.

as the broadcaster sees it

by Carl Dreher

Drawings by Franklyn F. Stratford

High Power and Elimination of Strays

THE only reason that static is bothersome, even occasionally, in radio reception, is that the amount of energy normally picked up from a distant station is almost incredibly minute. Dr. W. R. Whitney of the General Electric Company, is reported to have calculated recently, that the energy expended by a house fly in climbing one inch up a wall, is equal to the total energy which would be picked up by a one-foot loop at Schenectady, New York, from a normal broadcasting station in San Francisco, *over a continuous period of 35 years.* Yet we know that, given a suitable receiver, reception of KGO on a one-foot loop at Schenectady is not an extraordinary feat. It is the amplification required—and available in a good set—which is extraordinary.

When amplification is raised to this level, it is to be expected that any natural or artificial electrical forces which may happen to be hanging about will also make themselves heard in the loud speaker. Leaving aside the relatively rare periods of local lightning, static interference is not caused by the strength of the static, but by the weakness of the signal. The static is not particularly vicious, but we stick our hands into its cage, in DX reception, and invite it to bite us. Or, to change the metaphor, we look for needles in a haystack, and then complain of the hay. Archimedes said that given a long enough lever, and a place at the fulcrum to rest it on, he could move the earth. The modern radio engineer can paraphrase Archimedes with the declaration that, given enough stages of r. f. and a. f. amplification, he can sit in California and hear all the x-ray machines in Maine; or, since we are talking about static, he may hear all the lightning flashes in Korea and all the meteorites hitting the Heaviside layer, assuming that this cosmic bombardment gives rise to certain varieties of static, as has been alleged by some specialists in the subject.

In discussing static interference in radio it is necessary to differentiate between interference with program service and interference with distance reception. Static frequently interferes with distance reception, particularly in the summer, because the received signal requires great amplification. Interference with program service is relatively rare. When the signal from a given station in a given locality is strong enough to ride over the usual disturbances, this ability being taken as the criterion of program service, it will be found that periods of abnormal disturbance are not as unusual as railroad wrecks or tornadoes, but neither are they more common than "rotten" pictures at the movies, or automobile tire punctures, or arguments with one's wife. In other words, as regards static, radio is in the position of other public utilities and domestic conveniences with reference to their peculiar difficulties; it is imperfect, but good, and not to be appreciated until one has to do without it.

While we are thus attempting to view the problem in its true proportions, it is not to be denied that a compact, cheap, simple static eliminator would be of great utility, especially to people who live several hundred miles from the nearest broadcasting station, and of even more value to listeners in the tropics, where static is at its worst. A nice little tube, to be connected in the antenna lead, which

would stop the static and let the signals go on down, would be just the thing. I would go to the five-and ten-cent store myself to buy one. Unfortunately, while many good men have attempted to invent some such device, and have brought great ingenuity and assiduity to bear, the job remains to be done. Very successful means of static reduction have been devised, but all are complicated and costly. They are used only in long distance radio telegraph circuits, where the plant investment is in any event great and where profits are more or less proportional to ability to ride over static disturbances. Most of these successful methods operate on the directional principle. The signal comes from only one direction, and the static may come from a different direction. If you can confine your reception within as narrow an angle as possible, pointing in the direction of the approaching waves of the desired station, you may be able to shut out an appreciable proportion of the static. This is the principle of the barrage receivers of Alexanderson, the loop-vertical combinations of Pickard, some of Weagant's devices, and the "wave antenna" of Beverage, Rice, and Kellogg. The latter employs antennas nine miles long for transoceanic reception. The antenna is supposed to be about a wavelength long, so even for broadcast reception one needs about a quarter of a mile. As yet no one has put up a wave antenna on Riverside Drive or Michigan Boulevard! In any case, for broadcast reception, the direction of all such telescopic receivers must be variable, since one will generally want to listen to stations in any direction.

Many aspiring anti-static gladiators come forward periodically with vest-pocket eliminators which do not work, but which add to the gayety of the industry. Recently the ancient device of two circuits, one tuned to the wavelength of the desired station, the other to some other frequency, followed by rectification in each branch, and an a. f. balance in a differential transformer, was once more revealed. This method was in its first flush of youth in about 1916; it was described in a paper by Dr. Cornelis J. DeGroot, "On the Nature and Elimination of Strays," (*Proc. Institute of Radio Engineers*, Vol. 5, No. 2, April, 1917.) Whosoever is interested can also discover, in the printed discussion following the article, some of the reasons why this plausible method will not work.

Another exhibit is found in an issue, early this year, of a trade paper advertising one of those five tube stabilized radio frequency sets. with three big knobs and two or three little ones, which is an imitation of an imitation of a five tube stabilized radio frequency set, but no doubt just as good. There is the usual cut, with captions on either side detailing the virtues of the set, and heading all the other claims is the bald statement, "It Eliminates Static." Of course it doesn't.

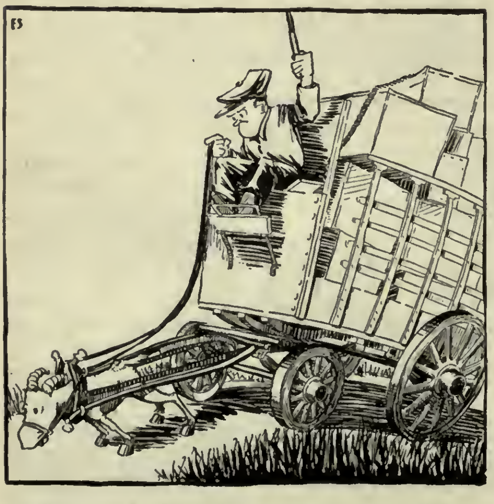
However, although the ordinary broadcasting receiver is not a static eliminator, it is important to note that when improperly used it may show a much less favorable signal-to-static ratio than when properly handled. The output of a vacuum tube is of course a limited quantity. If it is pushed too hard, a point is reached at which the signal volume can no longer be increased, while minor disturbances are still swinging the grids over the steep portion of the curve. This results in bringing up static or inductive interference or whatnot, to the disadvantage of the desired modulation, which is incidentally distorted. Not infrequently one sees receivers which are capable of delivering a clear, relatively disturbance-free output of moderate volume, pushed to a point where a mushy signal, full of squeaks, crashes, and hisses, but loud enough to be heard in the next county, is duly brought forth. A radio receiver of the usual design cannot be expected to do the work of a public address system, any more than a billy-goat can drag a five-ton load. If more people would form the habit of holding down the amplification to a comfortable level, complaints of radio noise interference would be greatly reduced.

they hunt for needles and object to the hay

Finally, freedom from static and other extraneous sounds is a matter of transmitting power. Given the power, we can ride over

anything within reason. With inadequate power, one is in the position of a man talking in a whisper in any crowded place. Radio communication is inherently a problem in amplification. In the studio one starts with energy of the order of microwatts—millionths of a watt. This is enormously magnified—to the level of say 500 watts in the transmitting antenna, but the method of distribution is such that the receiver gets only a few microwatts to work with. Once more this is amplified, until it is strong enough to actuate a loud speaker reproducing the original sounds. But here is the rub: where amplification at the transmitter brings up only the desired sounds, as amplification at the receiver magnifies these and all other impulses that happen to be flying around. The former is selective amplification; the latter is general, undiscriminating amplification, except in the one particular of frequency selection.

Thus even the engineer who is skeptical about static elimination at the receiver, sees no reason why static cannot be substantially eliminated by perfectly feasible increases of power at the transmitter. Largely, in fact, this has already been accomplished. People who live within a few miles of a powerful station hardly know that static exists. Farther out, they hear it occasionally, but it is hardly as annoying as the coughing at a symphony concert—a form of disturbance which, incidentally, is effectively eliminated for radio listeners by close microphone placing. With the constant increase in power of broadcasting stations, the area of practically interference-free reception increases in proportion. The time is not so far off when the area subject, more or less, to radio disturbances, will disappear entirely, just as the frontier of the United States disappeared, through the increase and distribution of the population, toward the end of the last century.



no more can a billy-goat pull a 5-ton load

Among the Broadcasters—Howard E. Campbell

MR. CAMPBELL was a radio man in the days when "broadcasting" was not yet in a radio man's vocabulary. He is now chief radio engineer and director of broadcasting for the Jewett Radio & Phonograph Company of Detroit, which is about to put into operation a 5-k. w. station at Pontiac, near that city.

Leaving the University of Indiana in 1909, Mr. Campbell enrolled in the Naval Electrical School at Brooklyn, New York, where trembling amateurs and professional aspirants, a few years later, were summoned for their operator's license examinations, before the Department of Commerce took over that function. But that examination Mr. Campbell did not take until in 1912, after spending most of the intervening period as a Naval Radio Electrician in Atlantic waters, for the simple reason that until 1912 there was no examination to take. With his first grade ticket he made one trip as a marine operator in the coastwise service, before being transferred to the Marconi Company's installation force early in 1913. Ultimately he became chief radio inspector at the port of New York for the Marconi Company, and no doubt held down many a key while squeezing the last milliampere out of the old quenched spark set. He also installed sets on sealing vessels in Newfoundland.

By this time, apparently, Mr. Campbell felt that he had graduated from marine radio, for, following a brief period as technical assistant at the Aldene, New Jersey, plant, he is next discovered as engineer-in-charge of the 300-k. w. New Brunswick, New Jersey, transatlantic station, which was a timed-spark outfit of the type still being used at Stavanger, Norway (LCM), for communication with the United States. New Brunswick was under test at this time, and soon after that job was in a stage of completion Mr. Campbell went out to Bolinas, California, to assist in the installation of a similar outfit for communication with Hawaii and Japan. All this, of course, was

in the dot-and-dash business; radio telephony was still in the incubator.

In February, 1917, Mr. Campbell was engineer-in-charge at Bolinas, and then the war came along. The day after the United States declared war against Germany, the station and all of its personnel were taken over by the Navy, Mr. Campbell remaining in charge with the rank of Radio Gunner. When the armistice was signed he was officer-in-charge of the Naval Radio Training School at Marshall, California, following which he went back to Bolinas, as Chief Radio Gunner, to recondition the station before it was turned back to the Marconi Company by the Navy. In May, 1919, Mr. Campbell was detailed as Radio Communication officer on the staff of the Pacific Coast Communications Superintendent, and this turned out to be his last assignment in the service, for in September he received his discharge and returned to his home in New York City, in plenty of time to participate in the broadcasting boom which started in the East in September, 1921.

HOWARD E. CAMPBELL

As soon as Mr. Campbell reached New York he made a connection with the Western Electric Company as radio designing engineer, and in that capacity he had much to do with the design of the first 500-watt radio telegraph and telephone transmitter, from which the present standard 500-watt broadcasting outfit was developed with comparatively unimportant modifications. Having been in intimate touch with the design, Mr. Campbell was ready to operate this equipment when he became chief engineer of station WWJ in Detroit early in 1922, and his success may be judged by the fact that this station was shortly cited by the Bureau of Standards as one of the few standard frequency stations of the country, varying from its assigned frequency less than one-tenth of one per cent. over a period of seventeen months. From WWJ, Mr. Campbell passed over to his present connection.

Mr. Campbell has been a full member of the Institute of Radio Engineers since 1914.

Radio Is Too Urban

FROM Miami, Arizona, comes a comment by Mr. W. H. Mayfield relative to the discussion of DX vs. Programs in our April issue. Mr. Mayfield points out, pertinently enough, that some listeners are DX hunters through necessity. "The closest station of any size," he writes, "is 450 miles, air line, whereas a 450-mile circle drawn around Mr. Dreher's listening post would undoubtedly include a hundred stations. We necessarily have to be 'DX hounds' here, if we are to get anything, and to listen to stations for selection after selection without announcement, and when the announcement is made to have it entirely unintelligible, or 'down in the trough,' as he puts it, is discouraging, to say the least."

Mr. Mayfield suggests that the announcer have a key and buzzer handy, and give the call signal in Continental Morse. There are numerous objections to this method. Here in New York only one of the announcers in my acquaintance knows the code well enough to learn to send even a simple combination of letters. Announcers are not chosen for telegraphic ability, but for a ready tongue, a pleasant voice, knowledge of music and showmanship, good manners and a measure of good looks. (The last to put female artists into a pleasant frame of mind, so far as possible). In the second place, nine-tenths of the listeners know as little code as the announcers. Thirdly, code signals, almost as much as key words like Watch George Yoke, would be out of atmosphere. At one station in the East there was a device for chopper-modulation of the carrier whenever the microphone was off, giving a characteristic monotonous note of musical pitch for listeners to tune to. It sounded pretty nasty on test, and was never put on the air.

The answer to the problem is twofold:

(1) Frequent announcing with modulation not below the mean level of the music. We shall be glad to hear from listeners about stations which

neglect to give their call letters at reasonably frequent intervals, it being borne in mind, however, that on some types of programs, such as church services and theatrical features, frequent cut-in announcements may not be feasible.

(2) Adequate power to reach the backwoods. Radio is at present too much an urban proposition. The people out on the plains and up in the hills need it as much, and more, and they will buy the sets when the service is offered them. One of the kings of France—Henry was his name, but I don't recollect his number offhand—who had a great zeal for the welfare of his subjects, declared his ambition was that every French peasant should have a fowl in his kitchen pot on Sunday. Well, every American farmer must have a radio signal field strength of 1.0 millivolt per meter in his front yard on Sunday and every other day. When all announcements made are certain to reach the listeners, then the determination of the proper frequency of call-letter repetitions will be a trifling problem indeed.

Is Government Action Needed on the S O S Question?

ON MARCH 21st there was another east coast SOS, and Mr. John S. Dunham, of Larchmont, New York, kept a log of the proceedings, sending a copy to Mr. Arthur Batcheller, United States Supervisor of Radio in the second district, and one to us. The record is very complete and covers from 7.46P, when the alarm was first given, to 8.27, when NAH (Brooklyn Navy Yard) sent out the "Resume traffic" message.

WEAF apparently got the original SOS, or an immediate relay, for it is in this instance in the honorable position of going off the air first, at 7.46. WJZ, WNYC, WOR, WGBS, KDKA, and others kept right on broadcasting. At 7.57, NAH, the naval control station in this district, sent out a QRT (Stop Sending). Thereupon WJZ took off its carrier, followed within a few minutes by WNYC, WGBS, and WOR (8.01). The inland broadcasters continued their programs, and WIP, Philadelphia, 508.2 meters, likewise failed to break its carrier, until 8.22, when Mr. Dunham's log states, "WIP at last off."

Mr. Batcheller, in a communication to Mr. Dunham, commented as follows:

"Class B stations only, which are on the coast and capable of interfering on 600 meters are required to cease transmission during the transmission of an SOS and signals relating thereto. Inland Class B stations and all Class A stations are not required to cease transmission."

That puts the SOS situation substantially on the basis we advocated in our first article on the subject in RADIO BROADCAST. (We do not mean to imply that that brought about the readjustment, which had probably been in contemplation for some time.)

However, Mr. Dunham feels that all stations above 300 meters should cease broadcasting when an SOS goes out, on the ground that damage to antenna or apparatus might necessitate the use of a lower wavelength than 600 meters, the standard distress call wavelength. He calls attention, also, to the case of WIP, which is Class B, near the coast, and not so far from 600 meters. There may be a difference of opinion on the first question, and evidently the Department of Commerce, having liberalized the rules, considers the low-wave distress call contingency remote. But, whichever way you look at it, there is little to be said in favor of WIF if Mr. Dunham's log is correct.

Dr. Frank W. Elliott, Manager at WOC, also contributes to this discussion, pointing out that the Department of Commerce has never seen fit to enforce the regulations as regards inland broadcasters, and that it would be difficult to pick up SOS calls on either coast at points in the Central states. He writes further:

"If some way could be developed to give information to the stations inland by telephone or telegraph I am sure that all would be willing to coöperate. I know that we would."

It was not our intention to criticise the inland broadcasters in this regard. We were calling attention to a general condition, using particular stations merely for illustration. The fact remains that some of the SOS calls which take the coast broadcasters off the air originate several thousand miles out at sea. A powerful inland station on one of the higher wavelengths might conceivably interfere with the traffic following such a call. The argument in the March issue was for a formula or some equivalent means of differentiating dangerous stations from the others. This still seems a rational procedure. It is merely one of a number of radio problems which could stand scientific investigation as a basis for appropriate action.

Receiving equipment exists which could give an adequate SOS service to those broadcasters, however, far from the coast, who might be designated to stand an SOS watch. Or, as Doctor Elliott points out, a wire service might be organized.

We are glad to hear from WOC, not only for their specific addition to what has been said on the SOS question, but because the exchang-

ing and debating of different points of view among the broadcasters is exactly what this department is here for.

The Memoirs of a Radio Engineer. II

BESIDES constructing an electrophorus, from which, when the weather was not too wet, sparks could be drawn, my companions and I built several detecting devices, or electroscopes. These were of two general types, which used metal foil and pith balls, respectively. The latter form consists very simply of two small sheets of gold-leaf or other very thin metal foil, suspended from a metal rod so that they will separate on the approach of an electric charge, owing to the repulsion effect between two similarly charged bodies. In our case, we stuck a fairly heavy copper wire through the cork of a pickle bottle, or any bottle of diameter uniform over the entire length, bent it over at the lower end, and hung pieces of aluminum foil over the horizontal part of the wire. The object of the bottle was to shield the apparatus from air currents. The proud operator of the electroscope would demonstrate it, before a gaping congregation of children, by running an ebonite comb, very likely stolen, through his hair, and bringing it close to the upper end of the metal rod or wire. Promptly the leaves would separate, standing stiffly apart at an angle of about forty-five degrees. For a small consideration, the spectators were permitted to rub the comb, each in his own hair, and by performing the experiment personally to satisfy themselves that there was no fraud. Many of them believed that the electricity was drawn out of the head, that some individuals had more than others, and that there was a peculiar virtue in having a great deal; arguments arose as to who had the most, and in the more acute cases led to fist-fights and neighborhood feuds. One boy in particular vaunted himself on his remarkable virility, for he was able to make the pieces of foil leap apart so violently that they reached the sides of the bottle and clung there. His enemies maintained, probably not without truth, that he was able to do this because his mother never made him wash his head. They caught one of the stray cats of the neighbourhood, rubbed its back with the comb, and proved that it yielded an even more striking effect on the electroscope than the hair of the champion, who stood near by, surrounded by his adherents, sneering. Finally one of them threw a rock, smashing the electroscope; the cat escaped, all the contestants, abandoning science, rushed to arms, and in the ensuing mêlée I received a bloody nose, neither the first nor last injury of that nature which I sustained.

The other type of electroscope worked on the same principle, but utilized pith balls suspended by threads. The pith we obtained by hunting for the dried stalks of weeds, which abounded in the vacant lots of the Bronx. Pith ball electroscopes were cheaper, and hence more common. One could be bought from the manufacturers, if I recollect, for about five marbles of the type known as "immies," while the aluminum foil product sold only for cash. As much as ten cents changed hands in some transactions.

These experiments were successful and profitable, but many other adventures in static electricity failed. For example, we were never able to build a static machine, or generator of static electricity with moving parts. Our greatest ambition was to own what is known as a Wimshurst machine, which consists of two glass disks revolving in opposite directions, with brushes and combs for drawing off a continuous charge. This was beyond our constructional ability, and we had no more chance of buying one, with the money derived from snow shovelling, running errands, and begging from our parents, than we had of buying a railroad or an automobile. Yet we yearned for one, hopelessly and yet pleasurably, as a farmhand longs for a Follies girl or a case of Scotch. Always there is something beyond one's reach, and one must accept substitutes. We tried to build a simpler electric machine, using a revolving glass cylinder rubbing against a silk pad, and we did succeed in mounting a bottle

they proved that there was no fraud

on a shaft turned by a crank, but no amount of turning and sweating got us an appreciable static charge, presumably because the glass was not the right kind. We fell back on the electrophorus as a generator.

Another great diversion was collecting or accumulating charges in condensers, which were known to us only in the form of Leyden jars. These we manufactured out of glass test tubes, coated on the outside with tinfoil, and filled with salt water for the inside electrode. By imparting about fifty charges from the electroscope to the ball of the Leyden jar, one could get a fairly severe shock on discharging the jar. This was far more entertaining than the comparatively feeble, painless, and less noisy sparks of the electrophorus. The spark of the Leyden jar was blue and loud, and by combining a number of test tubes one could get it to jump as much as a quarter of an inch. We persuaded one innocent youth to hold such a battery in his hand, and to present his tongue to the brass ball which was connected to the inner coating; the shock knocked him down, and in falling he broke the four condensers of the battery. Thus we were justly punished for our cruelty.

This incident marked the limit of our progress in electrostatics. We now turned to experiments with electric currents, as distinguished from static charges, and numerous galvanoscopes and galvanometers—devices for detecting and measuring electric currents—were built and torn apart. Our raw material was mainly in the form of old electric bells, which we bought from the neighborhood electricians for ten cents apiece. Some of them had been incapacitated by a coat of kitchen paint, others concealed a dead cockroach in their vitals, many had simply failed from old age, but they were all precious to us for the two electromagnets which they contained. Some of these we unwound from the core and rewound on cardboard forms, within which a magnetized sewing needle, suitably suspended, twitched violently when a dry battery was connected to the terminals of the coil. We attached scales to these instruments, but we had no means of calibrating them and so they never really measured anything. However, I do recollect building a tangent galvanometer, on which I worked for some months, the frame consisted of one of those small wooden hoops which are used in embroidering, which I got from my sister, by either force or stealth. The scale was correctly laid out, and probably the instrument was capable of fairly accurate measurements, but at the time I built it I did not know what a tangent was nor what part it played in the operation of the galvanometer.

Our great problem was a source of current supply, for when our dry cells ran down we frequently had no money with which to buy new ones. A dry cell cost a quarter, equivalent to five strawberry frappés or the same number of visits to the nickelodeon, as the then primitive movie theatres were called. Sometimes we were able to get more or less exhausted cells, from garages or electricians, at a much reduced rate, and various householders in the neighborhood, sympathizing with our endeavors, gave us their warn-out batteries. These we attempted to rejuvenate with injections of vinegar, salt water, and on one occasion I was inspired to try beer (5 per cent. alcohol in 1909) but the improvement was not worth the beer.

And now, at the age of about thirteen, we became telegraphers. Our communication was neither by radio nor over a wire, for at first we had only one instrument, which was communally owned and operated. The key and sounder were separate, and constructed mainly of wood, with a few screws and wires for the current-carrying and sounding parts. For example, the lever and the anvil of the sounder were both of wood, whittled from a cigar box, but screws were provided at the proper points in order to obtain the proper clicking sound. The sounder magnets were taken from a bell, of course, and likewise the armature. The difficulty of learning the Morse code dampened the ardor of all except some four of the group of urchins who had originally started out to become electricians. There was no drama in sitting in a cellar and making stupid clicking noises for hour on hour. We were considered to be obsessed by a dull and malignant spirit, and in fact we did go around telegraphing to each other by mouth signals of the dah-dit-dah variety, and many people took us for idiots incapable of intelligible speech. Even in school we practised in solitude by clicking pencils between our teeth or portions of the desks. Occasionally we would go down to a near-by railroad station and hang around the ticket office, listening to the sounders of the railroad telegraph, but the speed was much too great for us and we only caught a letter now and then. We looked with envy at the station master and wondered if we should ever own a real telegraph sounder of shiny brass, mounted in a mahogany resonator, with a tin tobacco can jammed between the anvil and the wood to give each sounder a

characteristic tone. As yet all we were able to get was the tobacco can.

It was not long before we were able to secure a few hundred feet of annunciator wire, and to build additional wooden keys and sounders, enabling us to connect our several homes and to spend our evenings telegraphing instead of doing our lessons. By that time we were good for about 12 words a minute in American Morse, with its spaced characters. Continental Morse, save perhaps in cable traffic, was not yet recognized in the United States. Even radio, in this country, started in American Morse and continued so for several years. As yet we were not interested in radio. We were aware that such a thing existed—"wireless," it was called, but no one knew anything definite about it. It was unknown, remote, nebulous, no doubt costly; we regarded it somewhat as a grocer thinks of celestial mechanics—not very pertinent to the practical business in hand.

(*To Be Continued*)

Microphone Miscellany

"Irate Listener"

ON MARCH 14th, early in the evening, WJZ in New York was rebroadcasting a concert from 2LO, London, the stuff going from the Savoy to 5XX, Chelmsford, by wire line, thence over the Atlantic on 1,600 meters, to be picked up at the Radio Corporation experimental station at Belfast, Maine, retransmitted on 112 meters, picked up again at the laboratories adjacent to Van Cortlandt Park, New York, amplified, and sent down to Æolian Hall on 42nd Street by wire line, where finally it modulated its last carrier and could be heard by any one within range of WJZ.

While the congratulatory telegrams were pouring in, a listener called up on the telephone, gave his name, and with unrestrained indignation spoke his mind, as follows:

"I listen to your station often and enjoy your programs . . . but your quality seems different. It isn't my set, other stations sound all right. There must be something the matter with your microphone. Why don't your engineers get on the job? Don't they know what they're sending out?"

Finally the studio attendant who had answered the telephone managed to get in a word, a great light burst on the complaining BCL, and with a single *Oh!* he hung up the receiver.

THINGS I AM TIRED OF ON THE RADIO

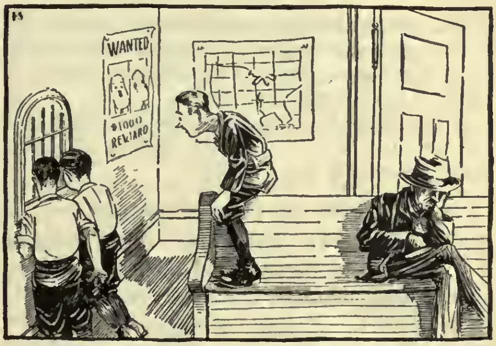
VIOLET ray machines.

Hearing middle aged sopranos coyly singing "The Lilac Tree," and, worse, seeing them do it.

Publicity stunts in which some self-styled musical genius broadcasts on 200 watts to his loving wife and children seated at the receiver in Tibet, 8,000 miles away.

Radio critics who turn out stuff like this:

> Nature, in a melting mood last night, was not generous to radio. Languorous air made thick the voices of soprano and barytone and injected squeaks into the tender violin. Though they brightened as the night waxed cooler, the effects were most lugubrious early in the evening.



we hung around the telegraph office

THOSE ELUSIVE TH'S

THE best broadcasting station in the world, and the finest receiving set and loudspeaker, can't as yet reproduce the consonant combination *th* to perfection. Thus when the announcer of a New York station, broadcasting from the annual radio show and convention at the Hotel Pennsylvania, told the radio audience, "The grand ballroom is all filled with *booths*, that innocent word came out on the air as *booze*, an altogether unintended indictment or compliment.

EVERYBODY BELIEVES IT, BUT IT'S NOT SO

SOMEBODY—probably Artemus Ward—said that it isn't the things we don't know that hurt us, but the things we know that aren't so. A few examples in the radio art:

> That a coupled circuit receiver cannot radiate.

"at their début all artists are panicky"

That broadcasting stations have a decrement.

That generators in a broadcast transmitter always result in a noisy carrier and that the only remedy is to buy a bank of storage batteries.

That artists appearing before the microphone for the first time are all in a very panicky state and about ready to faint with fright.

COMFORT FOR THE ANNOUNCERS

EVERYBODY, including myself, takes pleasure in harassing the announcers for their lapses, mistakes in diction, and whatnot, in spite of the knowledge that they have to make up what they say as they go along, admittedly no easy task. One would think, sometimes, that only announcers make mistakes. To disprove that theory, may we not present the first sentence of an announcement sent out by the wealthy and influential New York section of a national electrical organization

"There *has* been procured for our next meeting two speakers of prominence in the engineering and business world, who will talk. . . ."

Have the stenographer of the honorable secretary of the section no knowledge of English grammar? Have she no proof-reader? Have . . ."

What About a Broadcasters' Association?

IN THE United States and Canada there are about 600 broadcasting stations, with staffs numbering from one person up to sixty. Probably the average personnel is around four. That would make a total of about 2400 professional broadcasters.

There were not that many radio engineers in the world when the Institute of Radio Engineers was founded in 1912, and that was antedated by five years by the venerable Society of Wireless Telegraph Engineers. The technicians among the broadcasters are largely affiliated—and those who are not, should be—with the Institute of Radio Engineers. But broadcasting, after all, is a special occupation, and it is probable that before long the broadcasters, both program officials and technical men, will feel the need for some form of association of their own. In two or three or five years broadcasting will have got over its growing pains, and the energy for founding such a body will become available. Some of the owners of broadcasting stations already have an organization, but what we are thinking of is an association of the men who actually book the programs, make the announcements, and turn the knobs, and whoever may be interested in their work.

In the meantime, our hope is that this department of RADIO BROADCAST will serve as a broadcasters' forum, where all the practitioners and friends of the art will have a chance, not only to watch the general flux of projects and ideas, but also to express thoughts, contribute opinions, and to vent feelings which, in the present adolescence of the industry, frequently require such relief.

AN EFFICIENT RECEIVER FOR SHORT WAVES

ONE of the best known experimenters in the country, George J. Eltz, Jr., is developing a receiver for use on very short waves. The circuit employs super-regeneration—a highly efficient receiving method on the very high frequencies. Broadcast listeners who want to hear the short wave broadcasting now taking place at several large American stations, and transmitting amateurs will find Mr. Eltz' receiver an excellent addition to their equipment. It will be described in an early number

How to Be a Good Radio Neighbor

PART ONE: WHY YOUR RECEIVER SQUEALS

Helpful and Informative Discussion by Two Radio Authorities on the Menace of Squealing Receivers—How to Tell What Receivers Oscillate into the Antenna and How to Prevent that Oscillation—Practical Instruction on How to Operate Your Receiver Without Annoying Your Radio Neighbors

By JOHN V. L. HOGAN
Consulting Radio Engineer

GENERALLY speaking, there are two types of whistling interference heard in radio receivers. One type is the result of two broadcasting stations sending simultaneously at wave frequencies (wavelengths) that are too close together. Their waves react on each other and produce a more or less uniform whistling note, often of very high pitch, in all the radio receivers within range. This sort of interference is somewhat bothersome when listening-in on the present thickly populated broadcast wave bands It is daily growing of less importance, and for the moment we need not consider it further, although it will be discussed in a future article of this series.

The second type of whistling interference is caused by radiating receivers, or, in other words, by receiving stations that are so designed and so operated that they act as small radio transmitters. This kind of interference is exceedingly troublesome and breaks up a great deal of broadcast reception. It is particularly a nuisance in localities where there are many radio receivers close together, as in the cities; but even in the country this squealing and whistling interference often prevents satisfactory receiving.

It is safe to say that nearly every broadcast listener has heard the chirp or whistle of rapidly varying pitch that is the mark of this kind of interference. Many listeners, however, do not know what causes the troublesome whistles and many do not know that their own receivers may be adding somewhat to the nightly din of squawks and squeals.

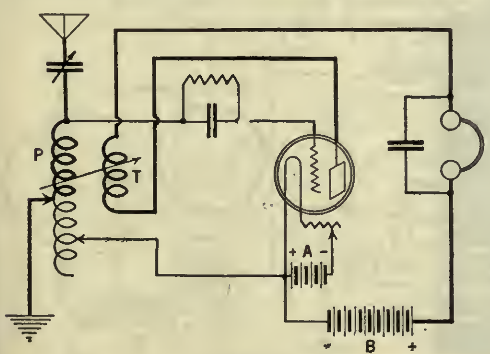


FIG. I

The old time single-circuit regenerative receiver which is the worst offender where radiation is concerned. When in an oscillating condition this circuit is a very effective transmitter

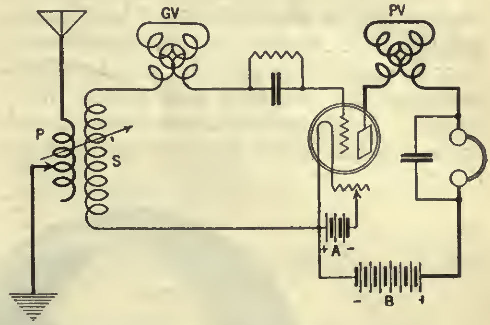
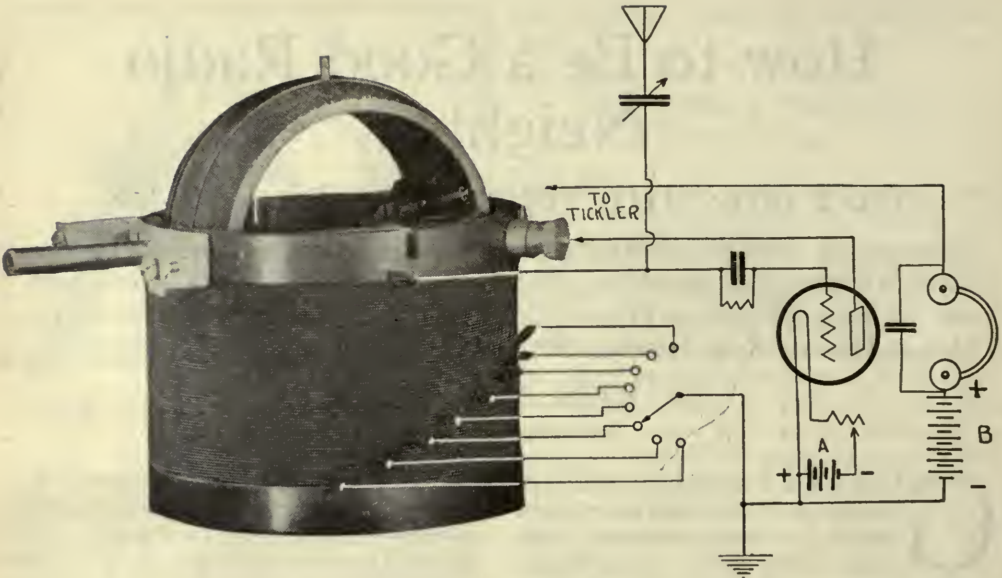


FIG. 2

The variocoupler-variometer circuit also is a generator of squeals. When in an extremely sensitive oscillating condition it possesses the ability to pass energy into the antenna circuit which creates interference in neighboring receivers

WHY WHISTLES OCCUR

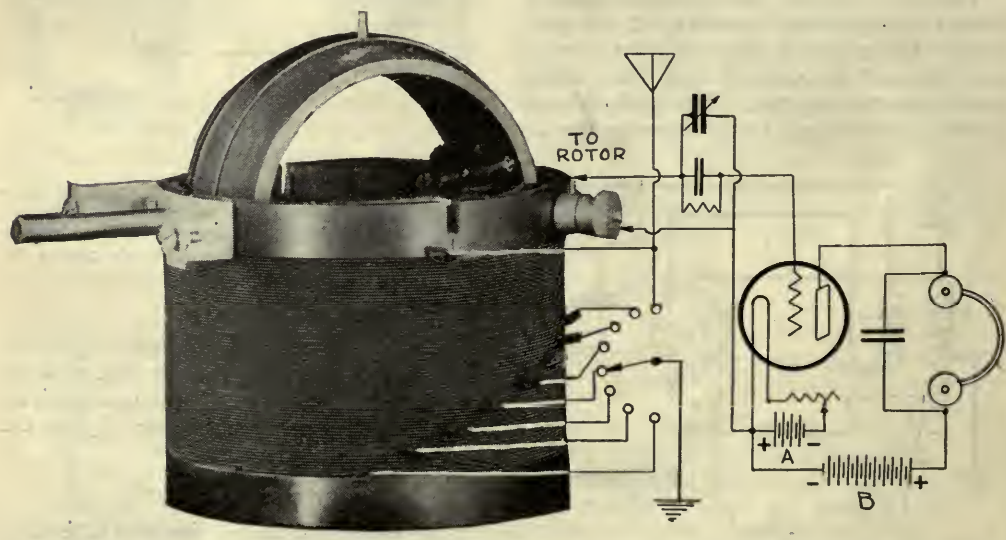
THE reason for these chirps and whistles is not known to many radio listeners, although the scientific basis of the action is not complicated. It is merely another mani-



THE INCORRECT WAY

Of connecting a variocoupler. Here the coupler is connected to a detector circuit with the rotor coil used as a tickler to produce regeneration. While this circuit is more sensitive than the one illustrated below, it is quite broad in tuning and is an excellent transmitter of squeals

festation of the common phenomenon of "beats" that is frequently noted in acoustics. You may have observed that when two musical tones of neighboring pitch are sounded simultaneously, the combined tone flutters in intensity. This happens because the two sound-waves interact or "beat" together, and the rapidity of the flutter is always equal to the difference in frequency of the two sounds. Thus, if two organ pipes of 32 and 36 vibrations per second, respectively, are blown at the same time, the sound heard will grow strong and weak (or flutter in strength) four times per second.



THE CORRECT WAY

A standard variocoupler consisting of a primary and secondary winding connected to the other essentials of the circuit in a way that will not cause the outlawed radiation. Tuning is accomplished by the variable condenser and the switch making contact with the switch points indicated

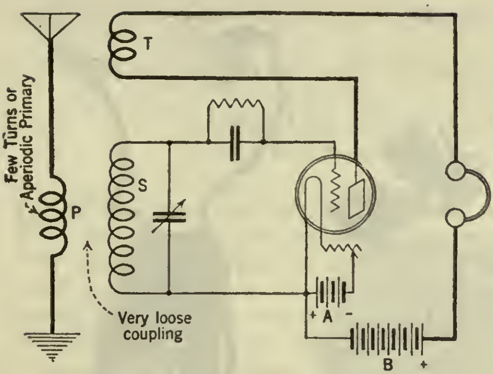


FIG. 3

The three-circuit tuner consists of primary, secondary, and tickler coils. Radiation may be somewhat diminished by employing a primary coil having only a few turns, loosely coupled to the secondary

In the same way, if two radio waves or two radio frequency currents of somewhat different frequencies are allowed to interact upon each other they will produce beats. Thus a carrier wave from station WEAF, at the frequency of 610,000 cycles per second, might interact with the carrier wave from another transmitter at 611,000 cycles per second to produce 1000 beats per second. When picked up and rectified, such beating waves would produce, in the listening telephones or loud speaker, a note of 1000 per second pitch, corresponding approximately to the second C above middle C on the musical scale. Any change in frequency of either beating wave would produce a change in the pitch of the beat note, since this must always equal the difference in the two wave frequencies.

In the same way, a carrier wave from any broadcasting station will beat with waves or currents produced by any self-oscillating receiving set. The frequency of the oscillations

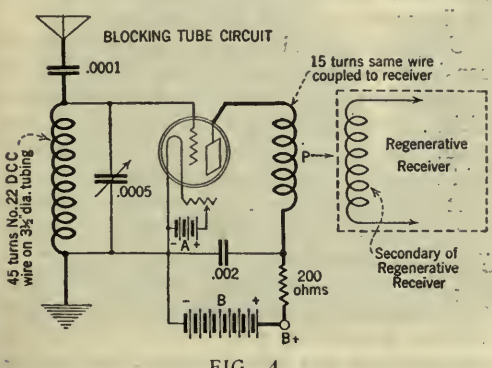


FIG. 4

A blocking tube circuit which was fully described in the March and May, 1924, issues of RADIO BROADCAST

in the receiver, and of the waves that those oscillations will send out if they are allowed to get into the receiving antenna, depends upon the tuning adjustments of the receiving set. As the tuning knobs are turned, the frequency changes. Consequently the pitch of the beat-note produced also changes, and this is what gives rise to the bird-like chirps and whistles that are so often heard.

If you have a radio receiver of any of the types that can be made to cause oscillations in the antenna circuit, your set is one that may interfere with your radio neighbor's reception. The receivers that can be made to generate antenna circuit oscillations, and thus to interfere with receiving throughout the neighborhood, are probably made and used in larger

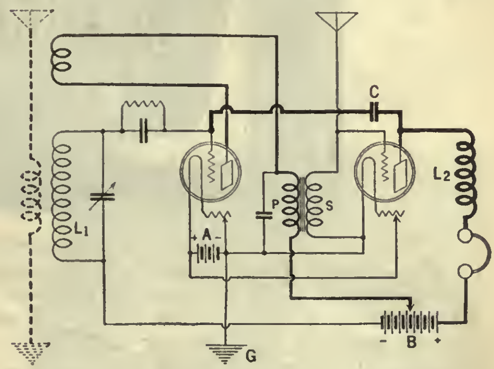


FIG. 5

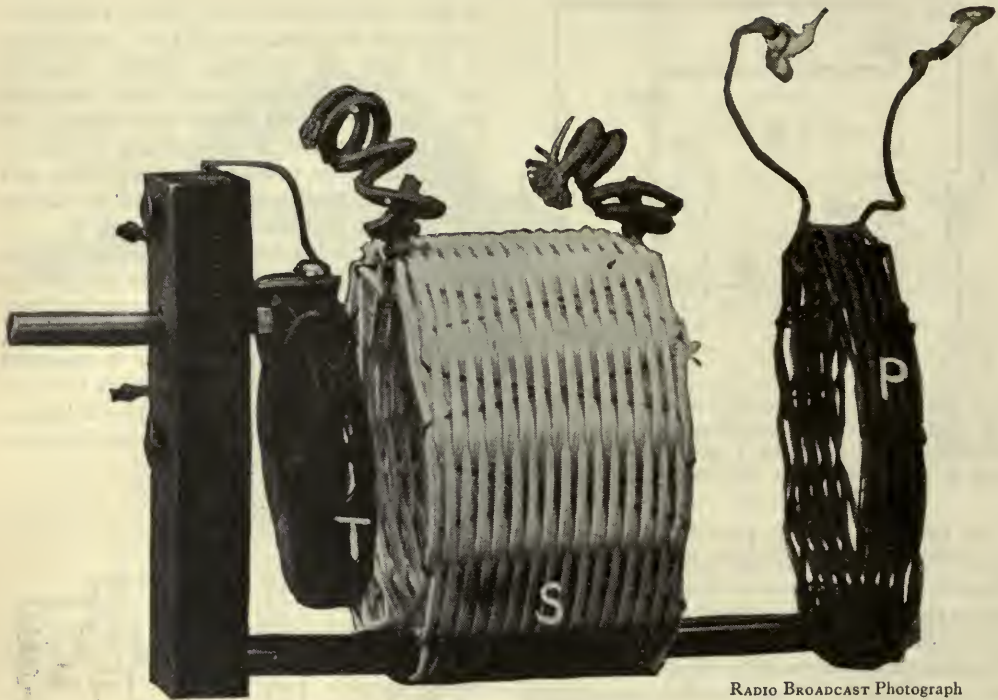
Is the recent circuit contribution to radio by Roy A. Weagant. A description of the additional apparatus and its method of use is contained in the text

numbers than the non-radiating and hence non-interfering sets.

TYPES OF RADIATING RECEIVERS

NEARLY, if not absolutely, all of the interference-producing receivers are of the simple regenerative type, though more complicated outfits such as the super-heterodyne, when used with an antenna, may cause this trouble. They may be of single-circuit double circuit, triple-circuit or of any other design; the offending set may be of the unneutralized radio-frequency amplifier or reflex type. Many of these will generate oscillations in the antenna circuit and produce interference if not specifically designed otherwise, particularly when they are not correctly handled by the user.

There are only two ways to stop the whistling interference produced by oscillating receivers. The first and simplest way is simply



Radio Broadcast Photograph

A THREE-CIRCUIT TUNER

Which illustrates very well the method of obtaining very loose coupling between primary and secondary to reduce the possibilities of radiation. The parts are labelled respectively T, tickler, S, secondary, and P, primary

to tune and manipulate your own receiver properly, and to teach your radio friends to do the same with theirs. A little work among your near-by radio listeners will produce wonderful results, for no one wants to trouble his friends. Ordinarily, by a little coöperation, a neighborhood can be relieved of the strongest receiver-produced whistles quite easily. The second and more difficult method is to arrange your receiver so that it cannot produce oscillations, or so that when it does oscillate, the currents will not reach the antenna. By preventing the generation of oscillations in your antenna you prevent the radiation of interfering waves.

IS MY RECEIVER OSCILLATING?

MANY of you are perhaps wondering how you can tell whether or not your own receiver is ever a source of neighborhood interference. There is one simple rule that answers this question: *If, when turning your wavelength or tuning control knob, you hear a whistling note in your telephone or loud speaker and if, also, you can change the pitch of that note by turning the tuning knob, you are making interference for all the listeners who live near you, unless your receiver is so designed that it will keep the oscillations out of the antenna circuit.* Whistles whose pitch you cannot control do not come from your set, and you need not blame yourself for causing them. On the other hand, if you have no blocking tube in your set, whenever you hear a whistle and find that you can vary its pitch by moving your tuning control, you may be sure that all your neighbors who are listening to the same station are hearing the same whistle. Thus you are not only spoiling your own reception but also theirs.

Unless you use a blocking tube, the wise and considerate thing to do is to keep your receiver adjusted so that it is *not* in an oscillating condition. Whenever you hear a whistle of this kind, stop your set from oscillating. If you will follow that rule and will impress its importance upon your radio friends, you will find that great reductions in the amount of whistling interference can be made.

The article which follows, by Dr. A. N. Goldsmith, gives a detailed description of how to tune without permitting your receiver to radiate and so show you how to protect your neighbors from interference caused by the oscillations of your set.

PART TWO

Operating Your Radiating Receiver Without Squeals

BY DR. ALFRED N. GOLDSMITH
Chief Broadcast Engineer, Radio Corporation of America

EVERY time your receiver produces a squeal in your own telephones or loud speaker, or every time it is in what is called the "oscillating condition," you are spoiling your neighbor's enjoyment of his concert and annoying people who have done you no harm. (There is but one exception to this rule, and that is the new non-radiating regenerative and non-radiating super-heterodyne receiver, which is specially built at the factory so that it will not radiate appreciably when used in accordance with the manufacturer's instructions. The definite "non-radiating guarantee" of a reputable manufacturer relieves the user of worry relative to this point). May I make an earnest plea to you, to apply the best possible rule of conduct, and to do to other broadcast listeners only what you would like them to do to you? Would you like to be interrupted by a loud noise while you were listening to a beautiful selection on the fine receiver which you bought or built recently, and which represents toil and expense? Would you want an evening's party ruined, after your guests had assembled to hear a particular concert which they were enjoying, by some inconsiderate outsider who, instead of being a good neighbor, is really a neighborhood nuisance? Surely you would not want either of these things. Then remember that it is up to you to consider other people.

HOW TO TUNE YOUR RECEIVER

BUT," you may rightly ask, "how am I to avoid bothering my neighbor? What must I do? No one has yet given me definite

RADIO BROADCAST Photograph

THE INCORRECT WAY OF TUNING

A regenerative receiver. Rotating the tickler or regenerative dial causes bird-like tweets to be radiated from your antenna. The effect on the neighbors is well known

instructions." And it is to give you a partial answer to your proper and reasonable questions that this article is written. In it, a few simple rules are set forth, which, if consistently followed, will make your neighborhood cleaner and quieter in the radio sense, and enable you and everyone else to be reasonably sure of an evening's entertainment whenever you want it by radio. Of course, the best and simplest way is to use a guaranteed non-radiating receiver. The following rules apply, however, to receivers which can radiate.

1. Find out what adjustment, or adjustments, on your set make it oscillate. By this I mean, turn the knobs of your set experimentally until you find that knob (or those knobs) which, as you turn them past a certain point, cause the well known squeal or tweeting birdlike sound in your telephones or loud speaker. Usually this knob is labeled Tickler, or Amplification, or Volume Control, or Loud-Soft or some such term. In some sets it is even marked Potentiometer. In other sets, there will be several knobs which cause the trouble of squeals, including the filament current control knob.

In all this, I assume that you are not using an ordinary super-heterodyne or super-regenerative set on an antenna. If you are, all I can say is, please don't. Put that set on a loop right away. If it does not work on a loop, it is so badly designed and built that it had best be replaced by some other set. Any one who deliberately uses a set which is continually oscillating—like the ordinary super-heterodyne or super-regenerative sets—on an antenna, is either ignorant of what he is doing or devoid of consideration for his neighbor. In the radio sense, he is a public nuisance.

Assuming, then, that you have found the knobs which cause your set to squeal, try to carry out the next suggestion.

2. a) Get a clear idea of the settings of each of these knobs where the squealing begins, for the stations to which you generally listen.

b) Then mark with a pencil the point on the scale of each knob where the trouble begins.

c) To make it still clearer, a small piece of white paper may be pasted next to the scale with its left hand edge at the point marked by the pencil.

d) The pencil or paper mark on the scale then represents the danger mark. Whenever you approach it, you are coming nearer and nearer to making trouble for others, and you should proceed with the utmost caution in so doing. (There are some sets for which this plan will not work because the settings of the knobs are too complicated and too variable. But it will work particularly well for many of the simpler sets.)

3. In using your receiver, develop the habit of slowing up the knob-turning process as you get near the danger mark. There are people who twist the Tickler knob around until they are sure that the set will produce squeals, and then they throw the wavelength control knobs for selecting a station, back and forth rapidly, thus producing a multitude of howls in other people's receivers. This is a vicious way of picking up a station. If such people knew what their neighbors thought of them, they would be astonished. Why store up ill will and discourage other people in their attempts to listen? Don't do it, but give them a chance by picking up only such stations as you can get WITHOUT HAVING THE KNOBS IN THE POSITION WHERE SQUEALS CAN BE PRODUCED. I know that this means very careful work in handling the set at times, particularly for receiving other than local stations, but it is truly worth while. Get into the habit, and you will be astonished how easy it will soon become.

4. If you have the kind of a set which produces squeals (and too many people have), be content with a little less distance rather than making so much trouble in the air. If getting a very remote station means a great deal of fussing and adjustment and a lot of squeals, you had better let it go, and listen to nearer stations. You will be a neighborhood blessing if you do.

INSTRUCTIONS FOR NEIGHBORLY RADIO

TO PUT it differently, don't overwork your set. Keep away from burning the filaments of the tubes too brightly or increasing the plate battery voltage or altering the set construction as received from the factory, or doing any of the other things which may possibly give a little more distance, but, on the other hand, make you a pest. If you have a receiver which does not radiate (and there are some excellent varieties now on the market), leave its construction severely alone. It left the factory in proper shape and if you meddle with it, you are bound sooner or later to put it out of order.

It is hoped that there is not too much of the sermon in this article. But it is so simple a matter to avoid producing squeals that refusing to take the slight trouble necessary to avoid them is like throwing banana peels on the sidewalk. It may be a natural and thoughtless

act, but the man whose leg is broken when he slips and falls, knows that you have been guilty of criminal carelessness. The person who produces radio interference deliberately is not only violating the law of the land but is also devoid of the spirit of community helpfulness. Broadcast listeners of the United States, give an extra minute and a little thought to your neighbors when tuning your set, and urge them to do the same for you.

THE WEAGANT RADIATION ELIMINATOR

Early this year Roy A. Weagant, Chief Engineer of the Deforest Radio Company, released to the public the circuit diagram showing the use of a small choke coil and condenser in regenerative receivers for eliminating radiation. The circuit is that of Fig 5. The heavy lines show where these two pieces of apparatus are inserted in such a circuit. The usual antenna circuit consisting of the antenna, primary coil, and ground is not employed, the antenna coil being eliminated with the antenna connected to the grid of the audio-frequency tube and the ground connected to the negative side of the A battery.

The theory of operation as explained by the Deforest Company is as follows:

It will be seen from the circuit that the incoming signal is impressed upon the grid of the audio-frequency tube instead of the grid of the detector tube. This audio-frequency stage acts as a radio-frequency amplifier resulting in radio-frequency variations in its plate circuit. The insertion of the choke coil L2 produces a radio-frequency potential which is passed to the grid of the detector tube through the condenser C. Inasmuch as this condenser has a small value of capacity and the grid and plate capacity of an audio-frequency is very small, any oscillation of the detector tube causes only a negligible amount of radio-frequency current to be passed into the antenna. The capacity of condenser C is .000025 mfds. and the choke coil has a very high inductance. It is composed of many small coils connected in series. Each coil has a natural wavelength some place in the broadcast wavelength.—THE EDITOR

RADIO BROADCAST Photograph

THE CORRECT WAY OF TUNING

A regenerative receiver. Here, the tickler dial is turned nearly to zero. The tuning is mainly accomplished with the condenser dial, the first one on the left. Once a station has been received, the regenerative dial may be advanced, but not beyond the point where squeals are produced. In some receivers, the left dial is the tickler and the right the antenna tuning dial. A glance inside the cabinet will usually make this point clear

For the Radio Beginner

How to Make a Radio Receiver for $1.82

WE WHO have played and worked at radio for many years are perhaps prone to neglect the thousands that every month approach their first radio experiments. Beginners are apt to be discouraged by the complexities which are life and nourishment to the average fan, and to which, as a popular radio magazine, we have given the most attention. We have, however, published an occasional article for the less advanced enthusiast, and the reception which has been tendered them, has encouraged us to inaugurate a department, devoted to the education and interest of the radio beginner. He will find here articles on the construction of simple apparatus built from inexpensive material. Particular attention will be paid to the possibilities of five-and-ten-cent store parts.

The editor will be pleased to hear from readers to whom this department is dedicated, telling him what they would like to see in it, the problems they would like discussed, and the sets they wish to build. We shall gladly consider manuscripts and short notes dealing with the design and construction of simple apparatus and shall pay for acceptable material at our usual rates.

—The Editor.

RADIO to-day is neither an expensive nor a complicated proposition, unless the enthusiast himself desires to make it so. The advent of the five-and-ten-cent store into the radio field has cut the cost of almost all parts, and these, arranged into simple circuits, present the logical start for the radio beginner's first experiment.

The crystal receiver we are describing was constructed entirely of such items. They can be duplicated in almost any of the five-and-ten-cent stores scattered throughout the United States and Canada, for one dollar and eighty-two cents.

THE PARTS FOR THE CRYSTAL RECEIVER

THE parts used in the construction of this receiver are photographed before assembly in Fig. 1.

No. 1	Eleven plate variable condenser, built up of parts; totalling	$0.77
No. 2	Dial	.10
No. 3	Crystal detector stand	.10
No. 4	Fixed condenser, .001 mfd. capacity	.10
No. 5	Crystal for detector (shown in detector stand)	.25
No. 6	Lightning arrester	.10
No. 7	Switch lever with knob and bushing	.10
No. 8	Four binding posts	.10
No. 9	Winding form cut from pasteboard	
No. 10	Spool of No. 24 enameled wire	.10
No. 11	Switch taps (3 for 5c.)	.10
	Cigar Box	
	Total	$1.82

The lettering beside some of the parts, indicates the abbreviation by which they are designated on the diagram Fig. 2.

Extra equipment, if not on hand, may be added to the above list as follows:

Antenna Wire	$ .40
Insulators	.30
Telephone receivers	3.00

This brings the grand total for complete receiving equipment to $5.52.

If it is desired, a panel and cabinet can be substituted for the cigar box. This adds considerably to the cost. The writer preferred the box arrangement because it simplified construction, both in the drilling or working of the panel material and in the elimination of more or less elaborate fittings. The cigar box can be stained if desired, but when merely cleaned and sand-papered, it presents a not unpleasing appearance.

Following the accumulation of the parts, it is well to make sure that the necessary tools

are on hand. While this simple set can be constructed with no other implements than

A pair of scissors,
A jack-knife,
A screw-driver, and
A gimlet

a neater and quicker job can be made if these elementary tools are supplemented by

A brace,
A $\frac{1}{4}''$ drill,
Countersink,
No. 18 drill,
No. 27 drill,
Hand-drill,
Reamer,
A pair of wire-cutting pliers and
A compass or dividers

THE PANEL

THE cigar box should be of average size—about eight or nine inches long, five inches high and two and one half inches deep. The paper can be removed by soaking in hot water for one half hour. It should be sand-papered, dried, and sand-papered again. The hinged top of the box is discarded, unless it is attached with metal hinges.

Fig. 3 shows how the "panel" or bottom of the box is drilled to receive the mounted parts. A horizontal pencil line is drawn across the box half way between top and bottom of the panel. On the left hand side, a vertical line is drawn $2\frac{1}{2}$ inches in. This line will cross the horizontal line at A, at which point a quarter-inch hole is bored to pass the variable condenser shaft. The screw holes for the condenser are drilled according to the pattern or "template" furnished with the condenser, and are countersunk.

Two and one quarter inches from the other end of the panel, a second perpendicular line is drawn. Holes for the detector, the exact placing of which will vary with different obtainable detectors, are drilled on the upper part of this line. The switch lever and tap holes are located on the lower portion of this line as shown. The tap holes are drilled with the No. 27 drill, and the lever hole, B, with the quarter-inch size and thus reamed to fit the bushing. The radius of the taps

FIG. I
These parts, which altogether cost $1.82, can be built into a simple but efficient receiver. All parts, excepting the lightning arrester, item 6, are included in the receiver proper

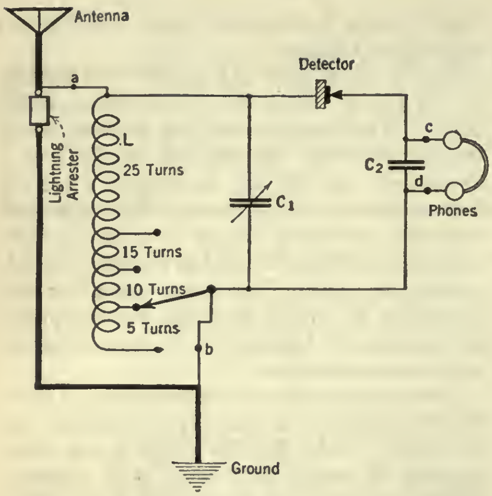


FIG. 2

How the different parts of the receiver are connected. The heavy wire in the antenna circuit should not be smaller than No. 14

will be determined by the length of the switch arm.

Each end of the box is drilled according to the right hand sketch in Fig. 3. These holes are for the binding posts.

Care should be exercised in drilling the box in order to avoid splitting. The metal drills are much preferred to the gimlet. The drills should be sharp and turned rapidly but with little pressure. This procedure will result in clean, unchipped holes.

After the required holes are drilled, the pencil lines should be erased by sandpapering and a coat or two of stain can be applied if desired.

THE COIL

WHILE the stain is drying—or perhaps while the paper is being soaked from the box—the coil can be wound. If the builder prefers, the winding form can be bought for a few pennies from the same ten-cent store that supplied the rest of the parts. But it is easily cut from stiff card-board in exact duplication of the drawing in Fig. 4. It is wound with 45 turns of wire, over three, under three, with taps taken with 7th, 14th, and 21st turns. Over three under three means over three spokes of the spider-web form, and under three spokes, as illustrated in Fig. 5. The turns are wound tightly. After seven turns are wound, a loop about three inches long is twisted forming a double lead. This constitutes the first tap. The winding is continued, additional taps being made, as directed, at the 14th, and 21st turns.

In connecting the set, looking at the panel from the rear, the start or lower terminal of the coil leads to the first switch point (from left to right), the 1st tap to the second switch point, the 2nd tap to the third switch point and the 3rd tap to the four or right hand point. The outer end of the coil leads to the antenna post. Loops are made in the tap leads, and the enamel scraped off, so that contact will be made with the nuts on the switch points under which they are placed.

Fig. 6 shows how the taps are twisted and connected to the switch points.

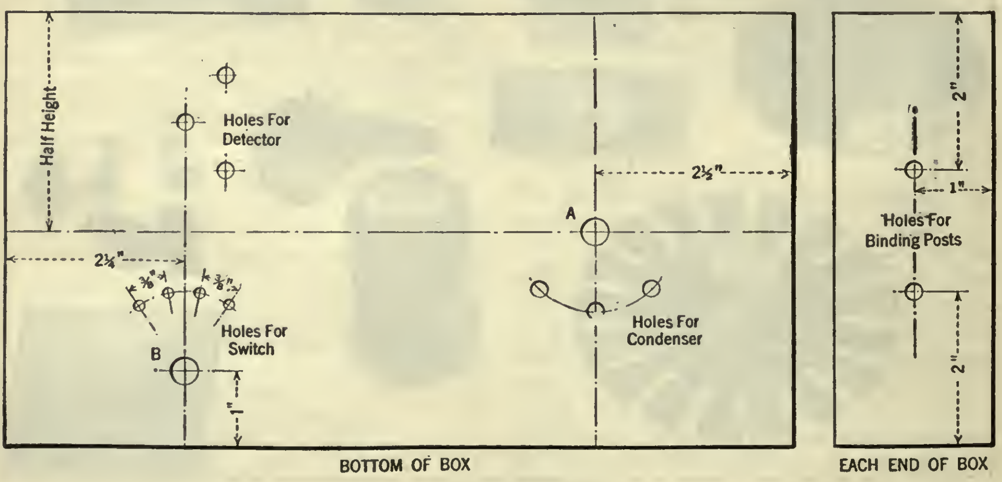


FIG. 3

"Panel layout." How the holes should be drilled. The condenser and switch point holes are most easily placed with a pair of dividers or a compass. Two binding-post holes are drilled in each end of the box

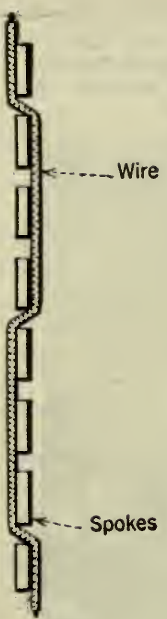


FIG. 5
The meaning of winding "over three, under three"

MOUNTING

AFTER the eleven plate condenser has been assembled (in many cases it can be bought complete for the total cost of its parts), it is mounted on the panel by the three screws provided for this purpose. If the holes in the panel are not quite properly spaced, they can be reamed slightly to compensate for any discrepancy. The dial is adjusted so that zero is at the top of the panel (at which point an indicating line may be inked in) when the rotary plates are entirely out.

The bushing for the switch lever and the four switch points are secured in their proper places. The crystal detector stand is mounted with a single screw through the center, two small holes on the right hand side being provided for the leads.

The remaining parts of the receiver, the fixed condenser and the coil, are supported by the wiring in back of the panel.

WIRING THE SET

THE internal connections of the set are shown in the diagram Fig. 2. Small "a" is the antenna post (upper left from the front) running to the top of coil L, to one side of the condenser, and to the crystal detector. The lower terminal and taps of the coil are connected as described. The bushing of the switch lever is wired to the ground post "b" (lower left) and to the variable condenser and telephone receiver post (lower right) "d". The upper telephone post runs to the crystal detector. The fixed condenser, C2, is connected across the phone binding posts, "c" and "d." Figs. 7 and 8 are rear and front views of the completed receiver. The connections within the set may be made with what wire is left over after winding the coil. The writer, however, had some No. 18 bell or annunciator wire, which, being larger and stiffer, was a bit better for this purpose. Using the parts photographed and described, no soldering was necessary.

THE telephone receivers are connected to the posts provided for them. The antenna is connected to "a" and the ground to "b." The lightning arrester, LA, is connected between antenna and ground as shown. The lightning arrester is conveniently mounted on the windowsill. The antenna wire should not be smaller than No. 14 B & S gauge, or its equivalent in stranded wire, and this same large wire should be used for the heavy leads shown in Fig. 2.

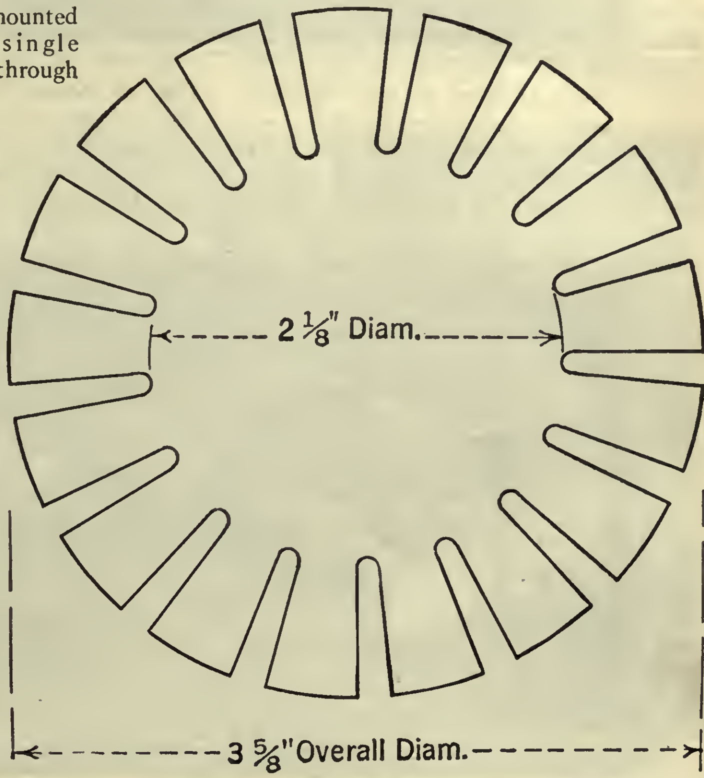
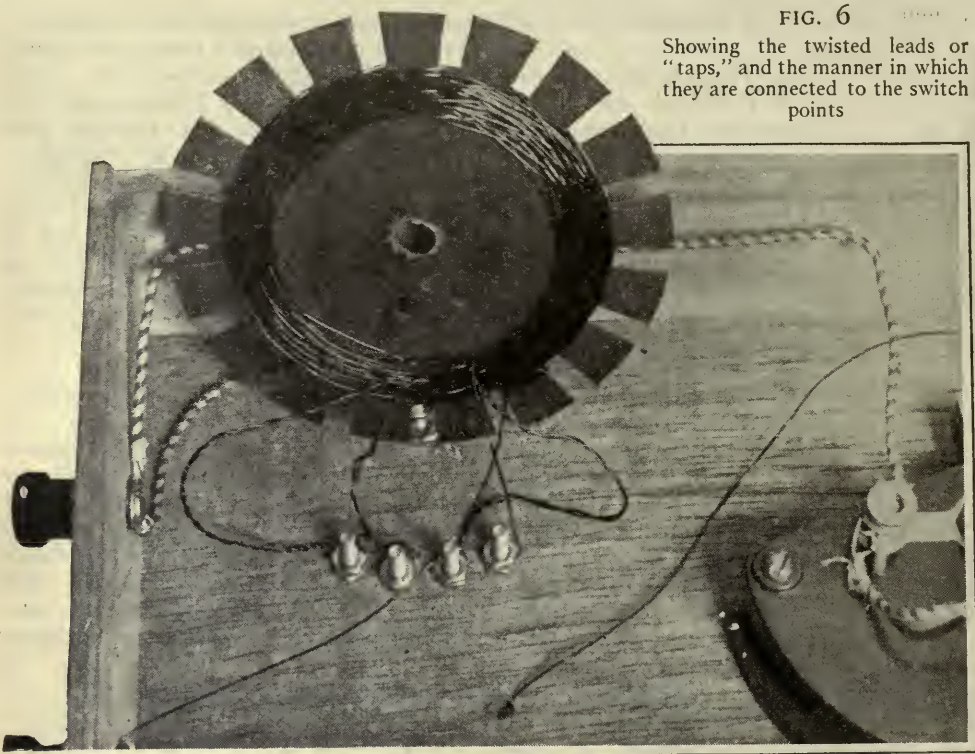


FIG. 4
A pattern for the coil form. This may be cut out and pasted on cardboard so that it can be duplicated exactly

FIG. 6

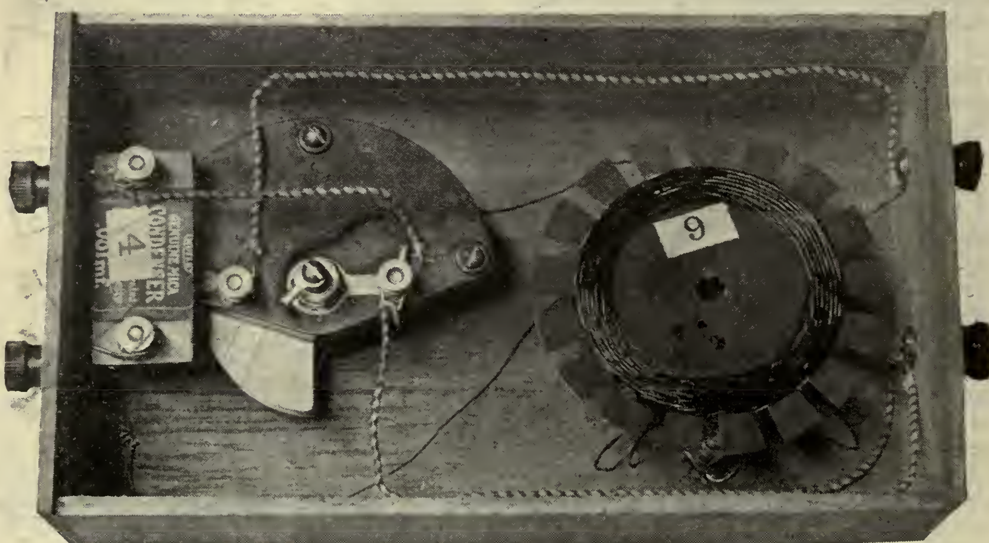
Showing the twisted leads or "taps," and the manner in which they are connected to the switch points



Radio Broadcast Photograph

WHAT ANTENNA TO USE

THE crystal receiver will operate on an indoor antenna, but will give much more satisfactory results on an outdoor system. For an indoor antenna, it is advisable to run a single stretch of wire through rooms and hall as far as possible without doubling back upon itself. No particular precautions need be taken for insulation, nor is a



Radio Broadcast Photograph

FIG. 7

Rear view of the crystal set. No soldering has been necessary in connecting the different parts

lightning arrester necessary with an indoor antenna.

A horizontal length of about seventy-five feet is best with an outdoor system. A longer antenna, while increasing volume and distance, generally boosts up interference in the same proportion. The antenna should be swung as high and clear as is conveniently possible. Low antennas and antennas surrounded by houses and trees will work, but efficiency will increase almost in proportion with the height and the absence of near-by dumbwaiter shafts, tin roofs, trees, and other absorbing obstructions.

The antenna should be insulated at each end, and, if possible, the horizontal and vertical (which means the lead-in) parts should be one long piece of wire, as suggested in Fig. 9. If two lengths of wire are used, they should be soldered at the joint. As a rule more than one wire for receiving is unnecessary.

The lead-in should be guyed away from walls if necessary, and should be heavily taped or otherwise insulated wherever it comes in contact with fire escapes, windows, etc. Remember, the crystal receiver depends altogether upon the energy the antenna system picks up, and it must be conserved by every practical care. There is no radio frequency amplification, or local batteries, and the telephone receivers are actuated by the minute currents induced by the radio wave.

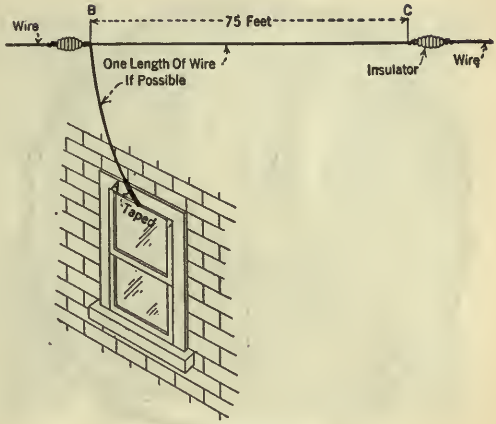


FIG. 9

A simple but efficient antenna system. If conveniently possible, the stretch A, B, C should be a single length of wire

The lead-in may be brought through the top of the window with the usual precaution of taping. Or, any of the several lead-in devices may be employed if the experimenter so desires.

Radio Broadcast Photograph

FIG. 8

The complete receiver, connected to antenna and ground, and ready for action. No batteries of any kind are necessary or desirable

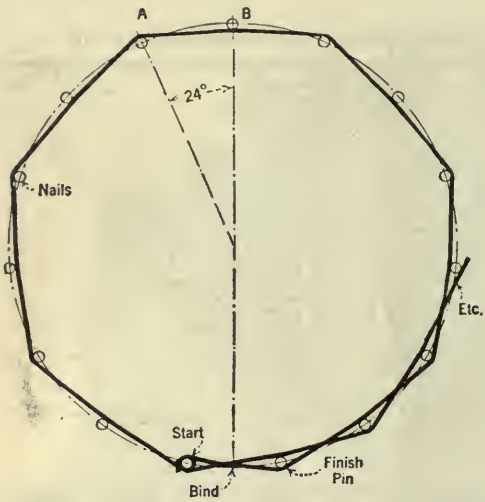


FIG. 10

The layout of the studs or nails, and the method of winding the simple low loss coils

THE GROUND

THE water-pipe or radiator make equally satisfactory grounds. The wire need only be wrapped tightly around a scraped portion of the pipe and taped. Such a ground, however, should be renewed every six months or so. A more permanent ground is secured by soldering or by using the common ground clamp. A ground wire can often be clamped under a valve nut on the radiator, forming a lasting and satisfactory connection.

HOW TO OPERATE THE RECEIVER

THE operation of even a simple receiver is a matter best taught by individual experience. A good starting point on our crystal receiver is to set the switch on the second tap, and tune for stations with the condenser while the detector is being adjusted. The process of adjusting the detector consists of moving the catwhisker lightly over the surface until a sensitive spot is found. It is a simple matter on most crystals obtainable to-day where the entire surface is comparatively sensitive. An occasionally difficult adjustment can be expedited by having someone ring the doorbell while the catwhisker is being moved. A rough buzz will be heard in the 'phones when a sensitive spot is discovered.

The highest waves will be tuned-in with the switch lever set on the right, the lowest waves on the left and the intermediate lengths in between.

HOW FAR CAN I HEAR ON A CRYSTAL?

THE probable range of broadcast receiving apparatus is little more than a matter of guess. It depends too much on individual conditions. Crystal sets have received distances over a thousand miles on many occasions. Using a short indoor antenna, stations fifteen miles away have been enjoyably received in our New York laboratory. Using an average outside antenna, the crystal set as we have described it should not be depended on for consistent reception of pleasurable loudness over distances in excess of 25 miles.

HOW TO MAKE A SIMPLE LOW-LOSS COIL

THE trouble with most low-loss coils, from the amateur's point of view, is the difficulty in executing the generally eccentric windings. The Lorenz, or basketweave coil is an exception to the rule, and it is probably more easy to wind than the straight solenoid. Like most low-loss coils at broadcast frequencies, losses are lowered, not so much by the type of winding itself but by the

FIG. 11 RADIO BROADCAST Photograph

The winding form and three Lorenz type coils. The left hand coil has been mounted on a standard honeycomb base

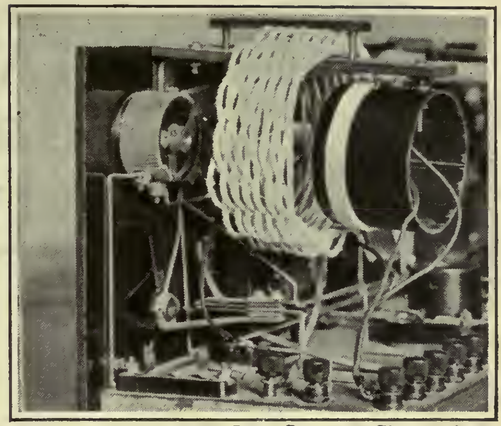
fact that the inductance (coil) is self-supporting. This eliminates much of the metal and insulating supports with their attendant inefficiencies and mechanical problems. Combined with the simplicity of construction, this added desirability recommends the Lorenz coil to the inexperienced experimenter.

A piece of scrap board and a handful of two or three inch nails represent the winding equipment. The heads should be cut from the nails. A circle the size of the desired coil is circumscribed on the board, and *an odd number* of nails driven into equally spaced points on the circumference. The arrangement of the points is best laid out with a protractor and dividers. Fifteen nails were used by the writer, which represents a spacing of 24 degrees of arc. Twenty four degrees are measured from the diameter with the protractor, and the same distance (A, B, in Fig. 10) is marked off on the circumference with dividers or compass.

The length of the nails is governed by the height of the contemplated coil and they should be driven firmly into the board.

The manner of winding is illustrated by the sketch, Fig. 10. Two turns are placed around the starting nail, and the winding commenced over one under one. The desired number of turns is wound and the coil completed by winding the wire twice about the finishing pin, which is one nail farther on than the starting pin. The coil is laced or bound before it is lifted from the nails. Thread is generally used for this purpose, tying in four places beginning with the crossing between the start and finish pins. The coil can be pried up with a knife or screw-driver sufficiently to pass the binding thread under the inductance. The black thread binding can be discerned on the left hand coil in Fig. 11, in which is shown the simple winding machinery and three of its products.

The Lorenz coils can be mounted in a variety of simple ways. The left hand coil in Fig. 11 has been soldered to the terminals of the standard honeycomb coil base. A more general form of mounting is to clamp the coils between strips of wood or bakelite as suggested in Fig. 12.



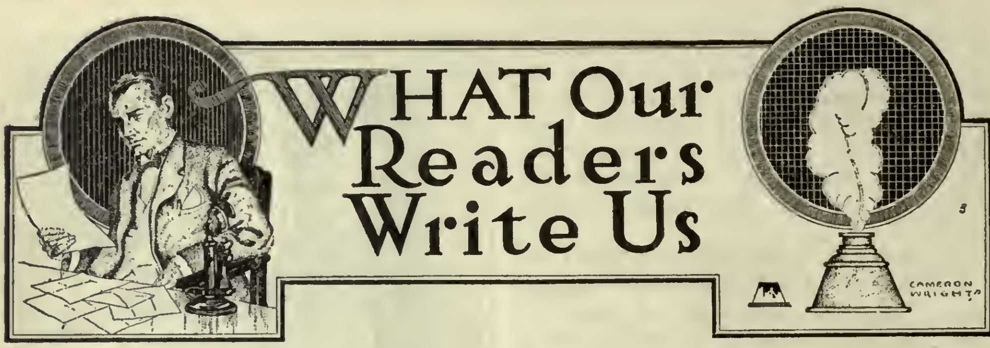
Radio Broadcast Photograph

FIG. 12

A simple way of mounting Lorenz coils is to clamp them between two strips of wood or bakelite

Primary and secondary coils can be wound alongside of each other as is occasionally done in the case of solenoids. It is a good idea, however, to overlap two turns in order to insure strength in the unit. The secondary should be started two turns before the completion of the primary. After one turn of the secondary, the next to the last turn of the primary is wound over the secondary turn. The second turn of the secondary is next made over the primary turn and the last turn of the the primary over the second turn of the secondary. The secondary is then continued by itself. The two coils are so interlocked that their self-supporting quality is not weakened. However, little is ever gained electrically by the winding of primaries in low-loss fashion.

Low-loss secondaries for broadcast wavelengths can be wound, of course, on various diameters. On a three-inch diameter, fifty turns should be wound and on a four-inch diameter, thirty turns. Shunted by a .0025 mfd. variable condenser, such coils will cover the broadcast band. If the reader desires, the inductance for the simple receiver completely desscribed on another page of this Department can be wound Lorenz fashion in preference to the spider-web. Either of the two coils just suggested can be wound, and taps taken at $\frac{1}{8}$, $\frac{1}{3}$, and $\frac{1}{2}$ the total number of turns.



Line Voltages Supplied by Power Companies

THE following letter was received the other day from the Brooklyn Edison Company, Incorporated, taking issue with a statement, in an article by Phil Fay, "Selecting a B-Battery Eliminator," which appeared in the March issue of this magazine.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR,

The first paragraph at the top of page 858 of your March 1925 issue, states that there are wide variations in voltage at different hours of the day and night on power circuits ranging between 100 and 120 volts. We believe this statement, as a definite statement, as made in your magazine, is incorrect and does electric supply companies an injustice.

While it is true that in some cases such a variation as you mention may take place on lines of some companies occasionally, it is not the usual practice and we believe that the statement would have been more correct if it had been stated that a variation in the amount of the proportions given may occasionally occur. The practice of this company is to permit a voltage variation of 4 volts either above or below the normal voltage of 120 volts which we supply. In other words, the range in voltage we undertake to supply is from 116 to 124 volts.

I hope that you will be able to make some correction of the statement referred to above in your magazine.

Very truly yours,
R. A. Paine, Jr.
Outside Plant Engineer

The paragraph referred to above is as follows:

"There are many differences between one power circuit and another. First, there are wide variations in voltage at different hours of the day and night, ranging between 100 and 120 volts. These are not noticeable in the brilliancy of electric lights or in the operation of ordinary household equipment, largely because this apparatus, unlike radio equipment, is not especially sensitive to voltage variations of this amount. In a current tap supplying a set line, voltage differences are of the utmost importance."

What Do the Roberts Knockout Users Think?

THE list of radio constructors all over the United States, Canada, and foreign countries who have written enthusiastic letters about their experience with the Roberts Knockout Receiver would fill many lines of type indeed. There have been a number of these correspondents who wanted to get in touch with others in their own vicinity to talk about their mutual experiences with the circuit and to discuss their various experiments with it. Keith Henney's article "Progressive Experiment With the Roberts Circuit" which appeared in RADIO BROADCAST for April, 1925, in especial excited a great deal of interest. "Can't you put me in touch with other radio fans in my city, who have been experimenting with this remarkable circuit?" was the question we received in more than one letter after that article appeared. As a matter of fact, similar requests, differently phrased, have come in the offices ever since the publication of the original article about this circuit by Doctor Roberts in the April, 1924, RADIO BROADCAST. The suggestion in the letter printed below is therefore not new, but it expresses very concisely what a lot of correspondents have been suggesting. RADIO BROADCAST will publish a list by cities and states of the names and addresses of Roberts Knockout users providing those users who are interested in taking up the suggestion outlined below will send us their names and addresses.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR,

About a month ago I wrote a letter to Mr. Zeh Bouck, partly personal and partly asking some advice regarding some trouble I was having with a Roberts Four-tube set I had built. I had hardly mailed my letter when the April number of the magazine came and informed me that Mr. Bouck was away on a vacation. The purpose of

this note is to have you, if you please, tell Mr. Bouck when he returns that I have since been able to settle my difficulties quite satisfactorily by changing the tubes. I wonder if this suggestion is any good? Let RADIO BROADCAST offer to print the names of some fans in each of the large cities who have built say two or three Roberts outfits and are willing to share their experiences with others. The Roberts circuit is so good that unless you treat it right in construction, you'll have trouble. A few *dont's* from one who has *done* only to his sorrow, may save perplexities later on. This is offered for what you think it worth.

Very sincerely yours,
(Rev.) Robert E. Holland, S. J.

What Doctor Pickard Thinks About Fading

THERE have been many interesting arguments presented of late upon the effect of weather conditions upon radio transmission. Doctor Pickard, Consulting Engineer of the Wireless Apparatus Company of Boston, has made an intensive study of fading in transmission extending over a period of several years and which has brought out much valuable information. His most important work probably has been his study of the eclipse of the sun in January, 1925. His observations during the period of the eclipse were reviewed in a paper which was read before the Institute of Radio Engineers in April, and dealt rather conclusively with this very interesting subject.

Doctor Pickard's reaction to Professor Van Cleef's article, which appeared in RADIO BROADCAST for May, is therefore, of especial interest. Mr. Van Cleef reviewed in his article the factors which influenced the transmission and reception of radio waves. There have been many theories put forth to explain the peculiar condition of fading. The most popular theory is, perhaps, that of the Heaviside Layer, which, in part, assumes that the various ionized layers of the upper atmosphere refract, absorb, or aid the waves in their passage. Doctor Pickard's letter follows:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR,

I am indeed indebted to you for the galley-proof of Professor Van Cleef's interesting article. We certainly need the aid of the meteorologist in the correlation of weather and radio transmission.

Few radio engineers who have specialized on transmission phenomena still retain the original or reflecting Heaviside Layer hypothesis. Not only did this hypothesis involve a grotesque amount and arrangement of atmospheric ionization, but to-day we realize that to act upon waves by conductivity would damp them out more rapidly than it would bend them. It is therefore refreshing to find a writer who pays no attention to the Heaviside Layer.

For nearly a quarter of a century it has been recognized that those happenings below the isothermal layer, which we call weather, were related to radio transmission. Some five or six years ago a Frenchman, whose name has temporarily escaped me, made a very similar analysis to that of Professor Van Cleef, although he came to somewhat different conclusions.

However, I do not share the author's assurance that reception conditions can be forecast with the same degree of accuracy as the weather, because I know several other factors profoundly affect transmission. But there is little that I can criticize in Professor Van Cleef's article.

The principal factor in radio reception is not the electric field at the receiving point, because this can be discounted by increased amplification. The principal factor, is, however, the height of the disturbance level or noise background. The fact that winter reception is better than summer reception is really due to two things. First, there is less static or noise background, and second, there is less sunlight, and therefore less ionization of the lower levels of the atmosphere.

Sincerely yours,
GREENLEAF PICKARD.

On Our Anniversary

IT IS a pleasure to receive letters of the sort reproduced below. Such expressions make us feel that our earnest endeavors to present to the radio public a magazine of the highest grade have not been wasted. But our efforts for the last three years have not been confined to the dissemination of the best in radio alone. In November, 1923, RADIO BROADCAST inaugurated the first International Broadcast tests. The tests were repeated in 1924 as they will be in 1925, and the data obtained from these tests as well as in many other and different researches conducted by RADIO BROADCAST has been invaluable to the radio field. Mr. Rice is Manager of Broadcasting for the General Electric Company.

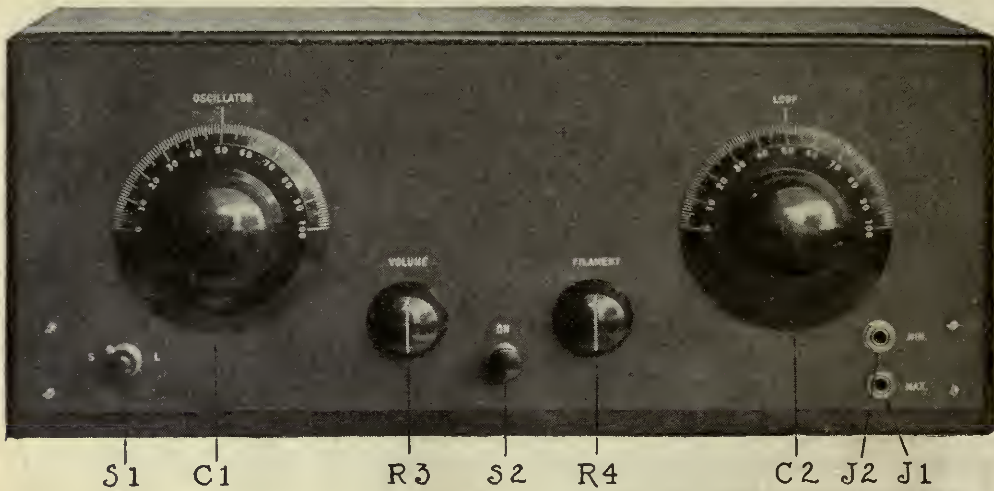
GENERAL ELECTRIC COMPANY

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR,

In looking over the May issue of RADIO BROADCAST I find that it is an anniversary number. I congratulate you on the high grade and interesting magazine which you have edited for the past three years.

Very truly yours,
MARTIN P. RICE.
Manager of Broadcasting.



RADIO BROADCAST Photograph

FIG. 1

Front view of the super-autodyne receiver, assembled on a standard 7 x 18 x $\frac{1}{4}$-inch bakelite panel. The knob at the lower left is the wavelength change switch which controls the loop. The designation letters in this Figure coincide with those in the list of parts, and in the remainder of the illustrations

The Super-Autodyne

Complete Data for Building an Improved Type of "Super-Autodyne" Using But Six Tubes for Portable or Home Use

BY McMURDO SILVER

THE super-heterodyne described in this article has a number of features which commend it to the radio constructor. In the first place, it uses six tubes, with a total plate current consumption of 12 milliamperes. As for actual mechanical arrangement and layout, we feel that the author has done a very good bit of design, for the set is exceptionally easy to wire, and if the constructional outline is carefully followed there should be no difficulties from this source. The entire receiver has been concentrated in a 7 x 18-inch panel, a vastly more compact arrangement than one finds with most super-heterodynes. No reflexing is used. The quality of tone we believe excellent. It is somewhat difficult to tune this receiver, as the dial functions differ from those in the common types of super-heterodyne. The interested constructor will, however, find that this is not merely "another super-heterodyne." Many radio enthusiasts, old and new, are looking for a portable loop receiver to use in vacation trips this summer; this receiver should satisfy their summer requirements as well as giving them a set for all-around home use.—THE EDITOR

THAT it possess features which definitely lift it above the class of the best receivers heretofore developed—is the first requirement of any new receiving system in order that it may, in a measure, justify that age-old human cry of "something new under the sun." And if for purposes of differentiation it is elected to call this new receiver by a name which includes the word "dyne," then there must certainly be something to recommend it other than that its designer has managed to unearth some new prefix or suffix for that word. The receiver to be described in this paper has but two basic claims to the first of these requirements and one to the second—it uses but six tubes, and its name is as logical as that of the super-heterodyne.

Essentially, the receiver is a super-

heterodyne, employing an autodyne detector-oscillator, and what the writer believes to be an exceptionally efficient intermediate amplifier. Because of the use of the autodyne frequency-changer, the circuit has been called a "super-autodyne," which seems to be a more logical name than "super-heterodyne." It might be argued that the usual interpretation of the word "heterodyne" implies the use of a separate detector and oscillator to produce a beat note, whereas in this system but one tube is used (autodyne). The name at least serves to distinguish this system from the conventional ones.

THEORY OF THE AUTODYNE CIRCUIT

THE autodyne circuit, which is the most interesting feature, is worthy of explanation. The difficulty which has heretofore prevented the use of one tube for both detector and oscillator has been that of isolating the loop or pickup circuit from the local oscillator circuit. It has been impossible to couple a tuned pickup circuit to a tuned oscillator when the two are to operate but fifty or sixty kilocycles apart throughout the broadcast wavelength range, and not have the tuning of one section react on that of the other. Armstrong and Houck developed the second harmonic system, whereby the oscillator, working at double the desired wave, did not react greatly upon the loop circuit. Then, a harmonic of the oscillator was used for heterodyning. This meant two waves of sufficient power to cause radiation were being produced by the oscillator, which necessitated the use of a muffler tube ahead of the detector-oscillator to prevent radiation. Thus, two tubes were still used, though the gain in signal strength was equal to or slightly better than that obtained with a good regenerative detector and oscillator. At best, this system is not entirely satisfactory for home assembly.

Then came the development of the balanced autodyne circuit, by J. H. Pressley, a Signal Corps engineer, which performs the required function with one tube.

The actual first tube circuit is shown in Fig. 9. The coils L2, L3 are theoretically equal, as are the condensers CX, CX. Actually they cannot be made fixed and equal, so CX, CX are made adjustable, to obtain substantially a condition of equality. These units make up a bridge circuit, shown by the heavy lines. Since L2 equals L3, the potential across them is equal, so that it is also equal between points 3, and 4, and 5 and 6. Likewise, the potential across CX and CX is equal. Since the potential across 3 and 6 is the same for both inductance and capacity, then point 4, 5 and the connection between CX, CX are at equal potential, and are also theoretically at zero potential, since these points are neutral with respect to 3 and 6. Then, circuit B1, C2, B2, may be connected at these neutral points with substantially no reaction on the

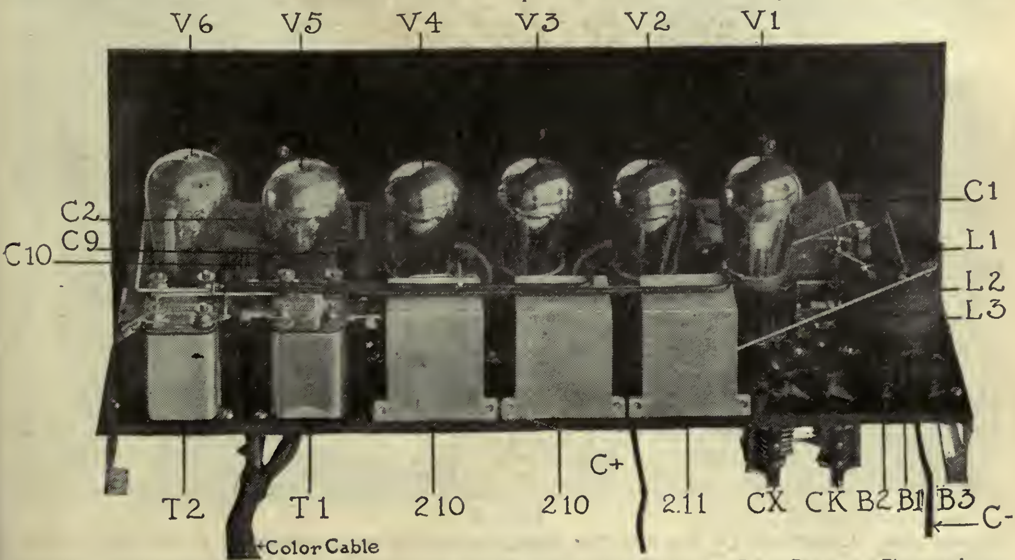
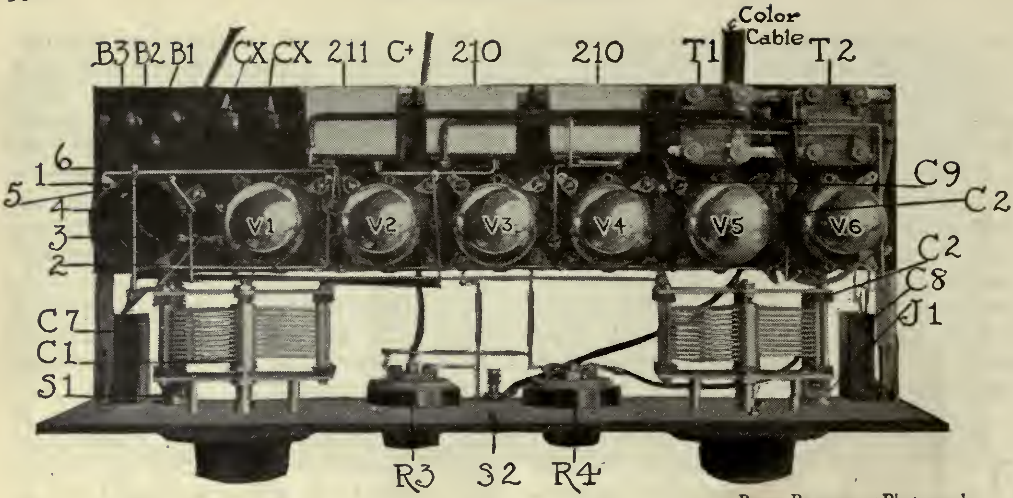


FIG. 2

Radio Broadcast Photograph

The completed receiver from the rear. Note how the color cable runs into the assembly, and how two of its leads terminate on the rear left posts of transformers T1 and T2. Condensers C9, and C10 should be fastened to the under side of the sub-panel, using holes provided in this socket-panel



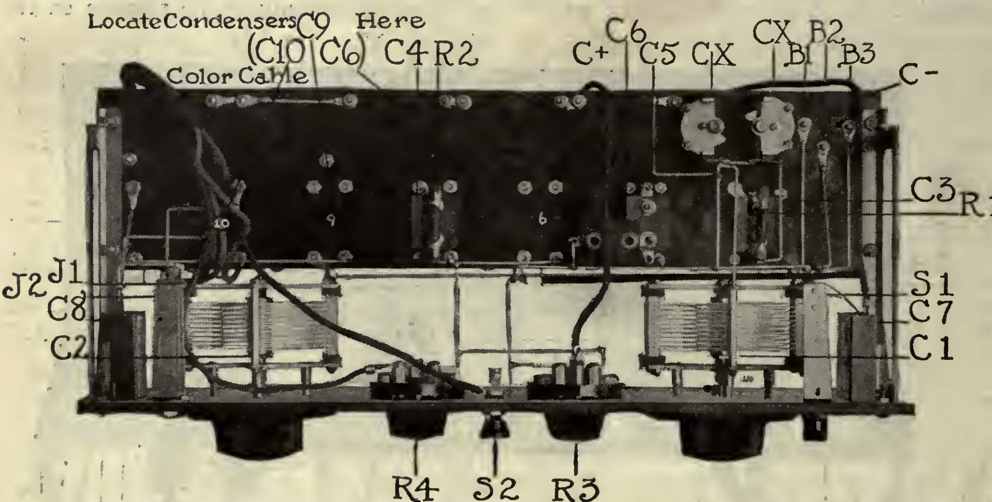
Radio Broadcast Photograph

FIG. 3

Details of the finished receiver from above. Note how the five leads of the color cable separate: one to the rheostat R3, one to the switch S1, two to T1, and one to T2. The gang-socket used in this particular model of the set is a home-assembly, and the springs are held by screws. In the factory product, the springs are held by hollow rivets which permit connections to be made from either above or below quite simply

frequency of the bridge circuit. Further, as these points are neutral with respect to 3 and 6, no energy in the bridge circuit can get into B1, C2, B2, since there is no potential difference across these points of the bridge. Therefore, the frequency adjustment of the bridge circuit cannot react upon that of the B1, C2, B2, circuit, and vice versa.

Since the signal is fed from the loop and its tuning condenser to the oscillator, it will divide equally across the bridge arms. If a tube detector is connected across one capacity CX, the drop in potential may be used to cause rectification. The coil L1, coupled to L2, L3, causes the bridge circuit to oscillate at a frequency determined by these coils,



Radio Broadcast Photograph

FIG. 4

Bottom view. Condensers C6, C9, and C10 should be fastened to the sub-panel at the points shown, similarly to C3, C4 and C5. The proper hole locations are given in Fig. 7. Connections from C3 and C4 to the socket grid terminals are by means of lugs, just visible between the condensers and the nuts to the rear left. This view shows quite clearly how the bypass condensers are held by the same screws holding the mounting brackets

CX, CX, and C1 which is made variable for the purpose of tuning the oscillator circuit. As previously explained, this energy cannot get into the loop circuit, so radiation is confined to what may be experienced from the oscillator coil system itself—a negligible amount.

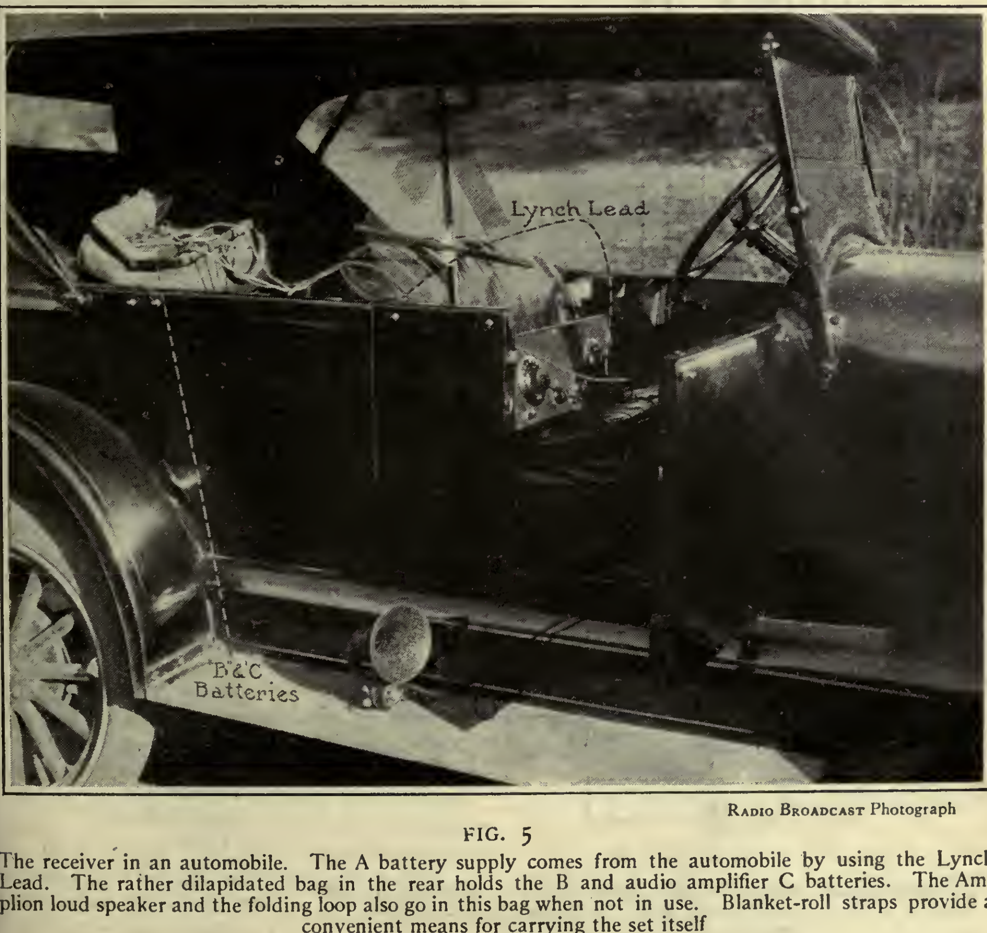
It is desirable that the losses in these circuits be kept low, particularly in C1, C2, CX and CX. Further, CX and CX should be quite small so as not to lessen the tuning range of the circuits, and in order that maximum voltage may be impressed upon the detector terminals. In some cases, it has been found possible to use the tube capacity for one condenser CX, while a very small variable was used for the other capacity.

INTERMEDIATE AMPLIFIER

THE intermediate amplifier is the only other unusual feature of the receiver. It employs but two stages and is on the order of those described by the writer in RADIO BROADCAST for October 1924, and January, 1925. It differs, however, in that it employs transformers which are a compromise between the extreme selectivity of properly designed air-core coils, and the great stability and amplification of good iron core transformers. But two core laminations are used in each transformer, of 7-mil silicon steel, one in the shape of an "F" and one an "L".

CONSTRUCTION OF THE SET

THE material required to build this receiver is listed below, with the designation letters used in the diagrams and cuts following the quantity of each item required. It is entirely permissible to substitute any other standard parts for those listed. The actual space available is such that if in some instances parts of larger or different dimensions are substituted, considerable difficulty will be encountered in making the units fit in the



RADIO BROADCAST Photograph

FIG. 5

The receiver in an automobile. The A battery supply comes from the automobile by using the Lynch Lead. The rather dilapidated bag in the rear holds the B and audio amplifier C batteries. The Amplion loud speaker and the folding loop also go in this bag when not in use. Blanket-roll straps provide a convenient means for carrying the set itself

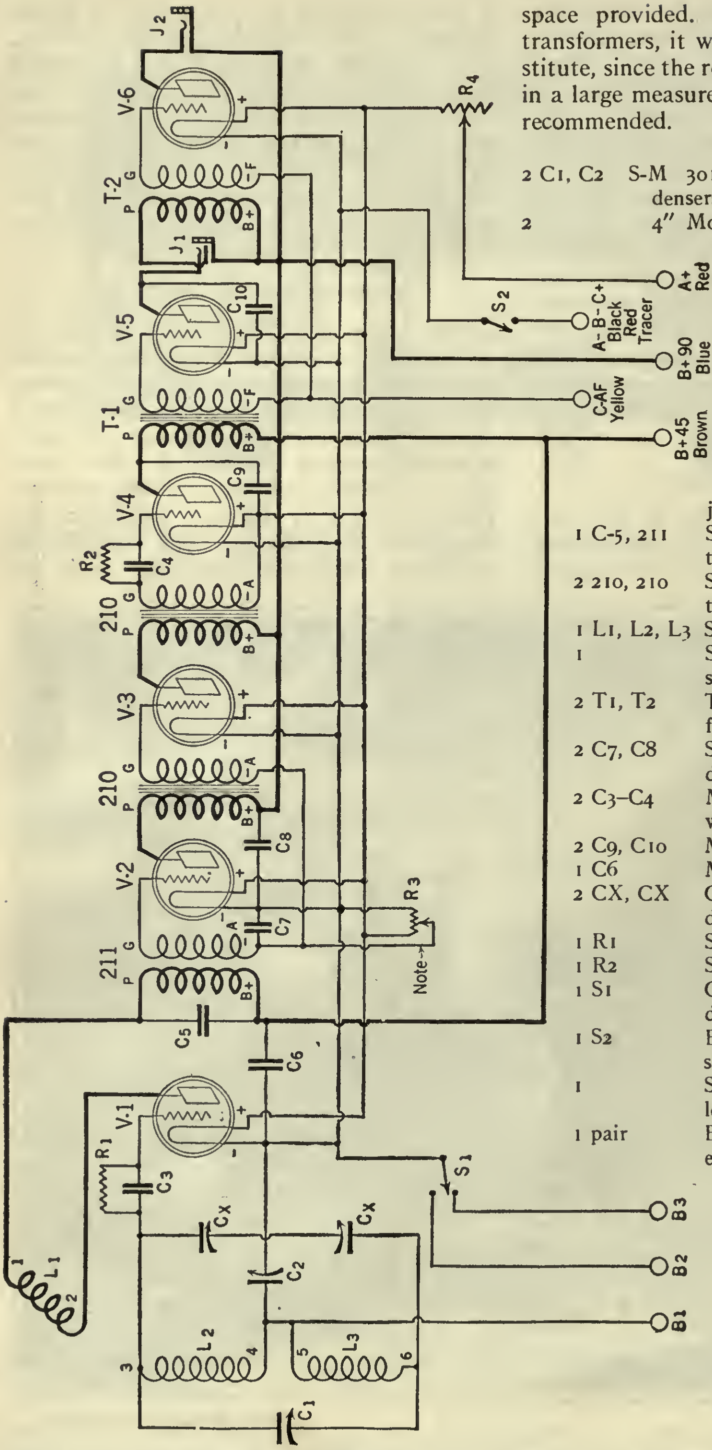


FIG. 6

Complete wiring diagram of the super-autodyne receiver. If this diagram is used in connection with the picture layout diagram, an error in connections is impossible

space provided. In the case of the r. f. transformers, it would be inadvisable to substitute, since the results of the receiver depend in a large measure upon the use of the types recommended.

2 C1, C2 S-M 301-A (or 305-A S. L. F.) Condensers
2 4" Moulded dials, vernier type preferably
1 R4 U. S. L. 6 ohm rheostat
1 R3 U. S. L. 240 ohm potentiometer
3 B1, B2, B3 Insulated top binding posts
1 J2 Carter 101 jack (1-spring)
1 J 1 Carter 102-A jack (3-spring)
1 C-5, 211 S-M 211 filter with matched tuning capacity
2 210, 210 S-M 210 charted intermediate transformers
1 L1, L2, L3 S-M 101-B coupling unit
1 S-M or Benjamin 6 gang socket shelf (536-201A, No. 537-199)
2 T1, T2 Thordarson $3\frac{1}{2}$:1 or 2:1 transformers
2 C7, C8 S-M or Dubilier .5 mfd. Condensers
2 C3-C4 Muter .00025 mfd. condensers with 2 clips
2 C9, C10 Muter .002 mfd. condensers
1 C6 Muter .0075 mfd. condenser
2 CX, CX Continental .000025 mfd. condensers
1 R1 S-M or Muter .5 Meg. leak
1 R2 S-M or Muter 2 meg. leak
1 S1 Carter No. 3 jack switch (s. p. d. t.)
1 S2 Benjamin 8630 switch (s. p. s. t.)
1 S-M No. 701 color cable (5 leads)
1 pair Benjamin No. 8629 shelf brackets
1 Bakelite Panel, 7 x 18 x $\frac{1}{4}$ inches
1 Small parts: 29 $\frac{6}{32}$ R.H. N. P. machine screws $\frac{3}{4}$ inch
2 6- R.H. N. P. machine screws $1\frac{1}{2}$ in.

31 $\frac{6}{32}$ nuts
1 spaghetti
10 strips bus-bar
25 lugs

Tools required: 1 hand-drill with drills and countersink, 1 soldering iron with rosin-

core solder and non-corrosive paste, 1 side-cutting pliers, 1 screw-driver, hammer, and centerpunch.

THE OSCILLATOR COUPLER AND GENERAL ASSEMBLY

THE oscillator coupler may be made by winding two sections separated $\frac{1}{16}$-inch apart on a $2\frac{1}{4}$-inch bakelite or condensite tube; each section containing twenty-eight turns of No. 28 d.s.c. wire. The rotor coil also consists of twenty-eight turns of the same size wire on a $1\frac{1}{2}$-inch tube rotatable within the stator tube.

As soon as the materials have been procured, each item should be carefully examined to see that all screws and nuts are tight, and lugs placed as shown in the photographs, so that those on the various instruments will point in the best directions for short leads. Socket springs should be bent up to make good contact with tube pins. Condenser bearings should be adjusted to give the desired tension.

If the builder already has Benjamin sockets, the socket-shelf may be made up by drilling a piece of bakelite $17\frac{1}{4}$ x $4\frac{1}{4}$ x $\frac{1}{4}$ inch in accordance with Fig. 7. The bases should be removed from the Benjamin sockets so that they may be fastened directly to the sub-base with their original screws. On each terminal will be found a round knurled nut, a hexagonal nut, and a round-headed screw. The screw should be put through the hole in the spring, pointing downward. The knurled nut is turned up on the screw under the spring, the screw pushed through its hole in the shelf, a lug placed over it if necessary, and the "hex" nut tightened up on the under side of the shelf. Care should be taken to prevent the spring from twisting as the nut is tightened, due to rotation of the screw. If this occurs, the socket will not ride evenly on its spring. Details of these operations may be obtained from Figs. 2, 3, and 4. Either UV-199 or standard UV-201A sockets may be used. They should be arranged so that their grid terminals come out at the left rear, as in Fig. 3.

The front panel may be laid out in accordance with Fig. 8, using a rule and scriber after which the hole locations should be punched with a center-punch or nail, and a hammer. After drilling the holes, the panel may be grained with fine sand-paper and oil, rubbing in one direction until the original polished finish has disappeared. After wiping the panel off with alcohol, indicating marks for the dials may be scratched as in Fig. 1, and filled with Chinese white. The sub panel should not be grained.

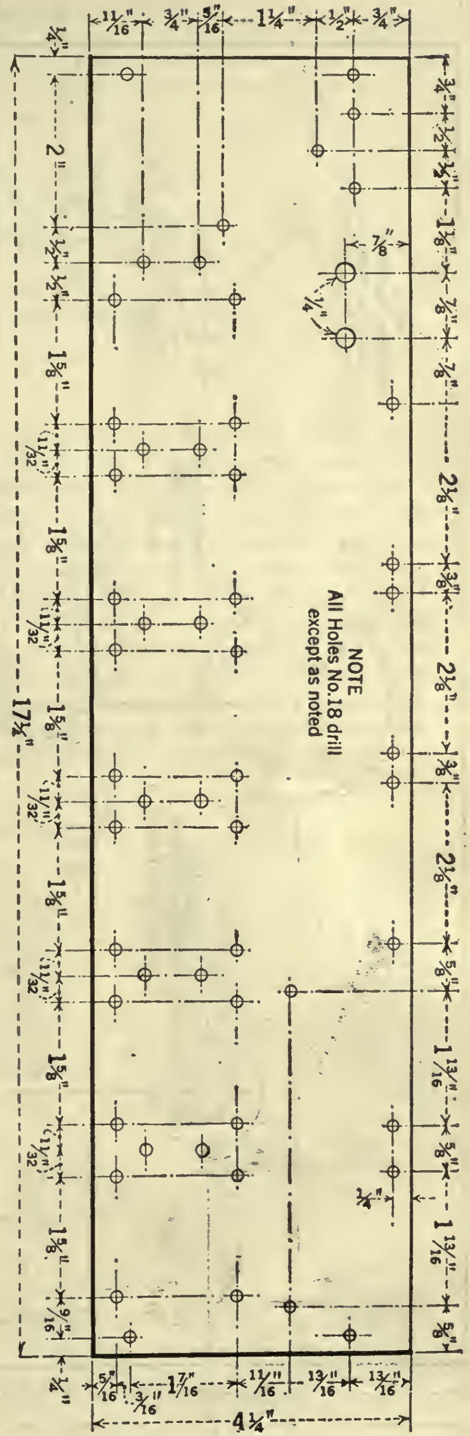


FIG. 7
Drilling dimensions for the sub-panel

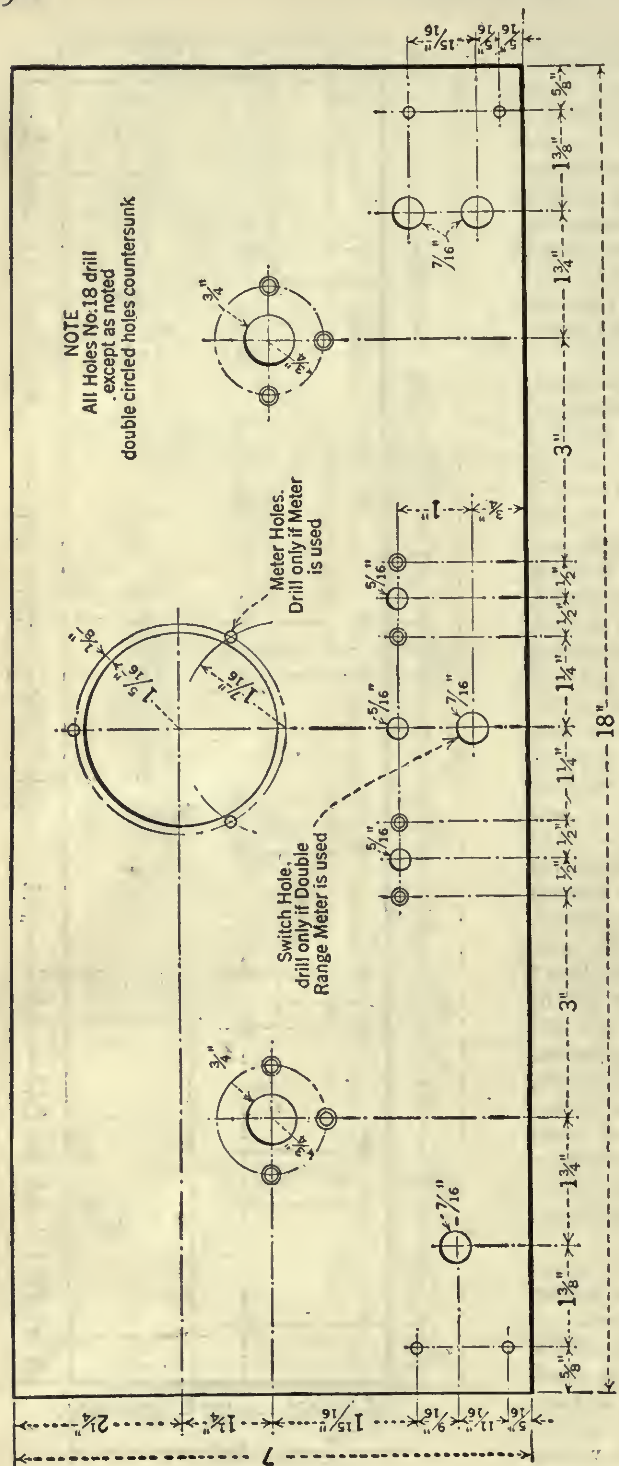


FIG. 8

Panel drilling dimensions. If a meter is used with this set, which is strongly advised, the holes indicated should be drilled. The Weston double range voltmeter type 301, which may be used on the panel requires the additional switch hole indicated

ASSEMBLY OF PARTS

BEFORE starting with the assembly, the photographs should be very carefully studied, to see just how each part is put on, and just where each of the different parts go. If the S–M or Benjamin shelf is used, it will be unnecessary to drill any additional holes, as these shelves are supplied completely drilled for the parts recommended.

Figs. 1, 3, and 4 should be examined to see how the parts are arranged on the panel. The condensers C1 and C2, the Carter jacks and jack-switch and the Benjamin switch should be put on the panel, followed by the rheostat and potentiometer. The posts of these latter instruments should be on the bottom, and their contact arms should point upward when their indicating arrows do likewise.

All parts should be put on the sub-panel as shown in the various photographs. In these C6, C9 and C10 are shown inconveniently located. They should be placed in the positions indicated in Fig. 4, on the under side of the shelf. They are held to the sub-panel by machine screws and nuts. Lugs placed between these condensers and the sub-panel may be soldered directly to the socket terminals in the case of C9 and C10, since they run to plate and F of sockets V5 and V6. Condensers C3 and C4 may have one of their contacts connected to the grid terminals of sockets V1 and V4 respectively in the same manner. Lugs for C5 should be placed on the upper side of the shelf, as well as on one terminal each of C3 and C4, since some of the condenser connections will be made from above.

WIRING THE RECEIVER

IN WIRING the receiver, a well-tinned iron should be employed in conjunction with rosin-core solder. A small amount of paste may be used on each connection if desired; but not on any of the fixed condensers. Here, connections

may be soldered to lugs, or to the condensers directly.

Only two connections can be put on the panel alone. These are a connection between the rheostat and potentiometer, and one between the potentiometer and S1. (See Figs. 3 and 4.) Bus-bar should be used, straightened, carefully cut, and bent to proper length before any attempt is made to solder it in place. A long piece of bus-bar should not be soldered to a lug, and then bent and twisted until it reaches the other lug to which it is to be soldered. Each piece should be bent to fit properly, cut to size and then soldered in place.

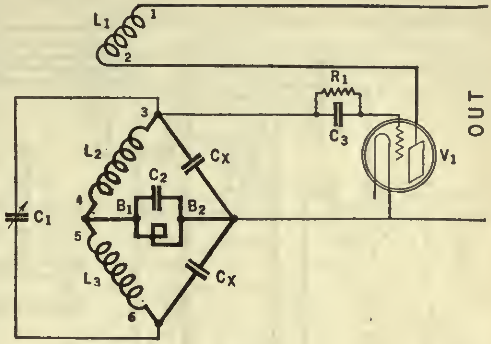
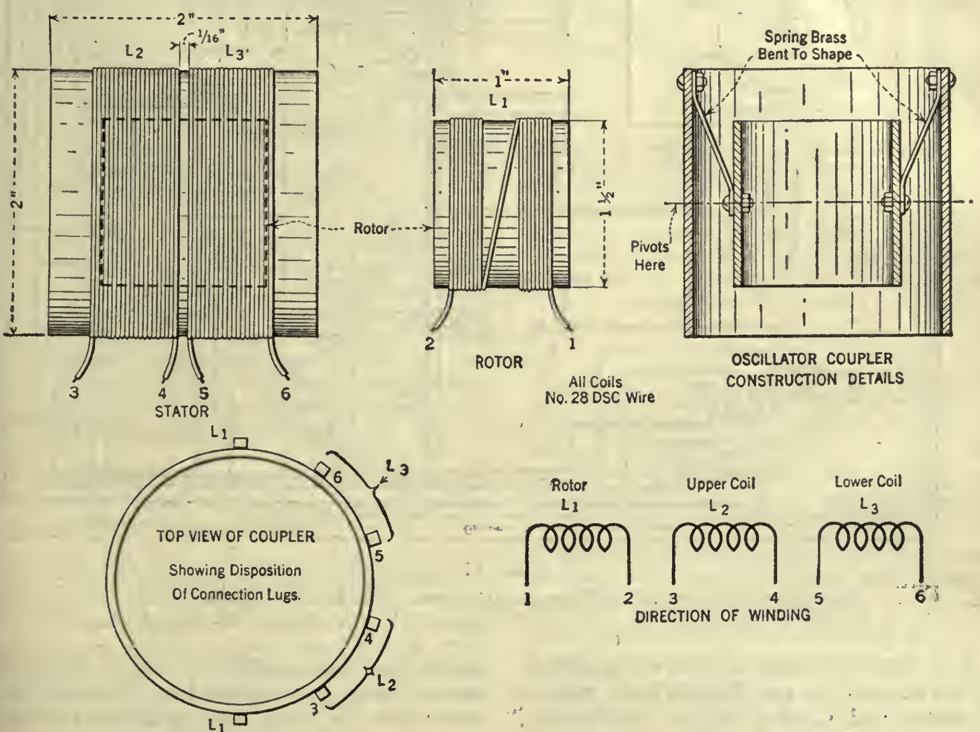


FIG. 9

ASSEMBLING ON THE SUB-PANEL

STARTING on the sub-panel, all the wiring visible on it in Fig. 3 should be put on, the shelf then turned over, and the wiring necessary on the bottom put in place. All of the r.f. and a.f. transformer cases are connected together, and in turn connected to the negative filament line, which joins the minus lugs of all sockets, just as the positive line joins all the plus terminals of the six sockets.

The Benjamin brackets should be fastened to the sub base, and in turn loosely fastened of the panel. The lugs of the bypass condensers C7 and C8 are bent at right angles, and slipped in between the brackets and fastening nuts, as in Fig. 4. This makes a solid mounting for these condensers, after the screws are tightened, as well as for the shelf-brackets. The balance of the wiring is then put in, running between the parts on the sub-shelf and those on the panel. This will not be found difficult, particularly if spaghetti is used only where there is danger of two wires shorting, or a wire shorting on an instrument.



DETAILS OF CONSTRUCTION OF THE OSCILLATOR COUPLER

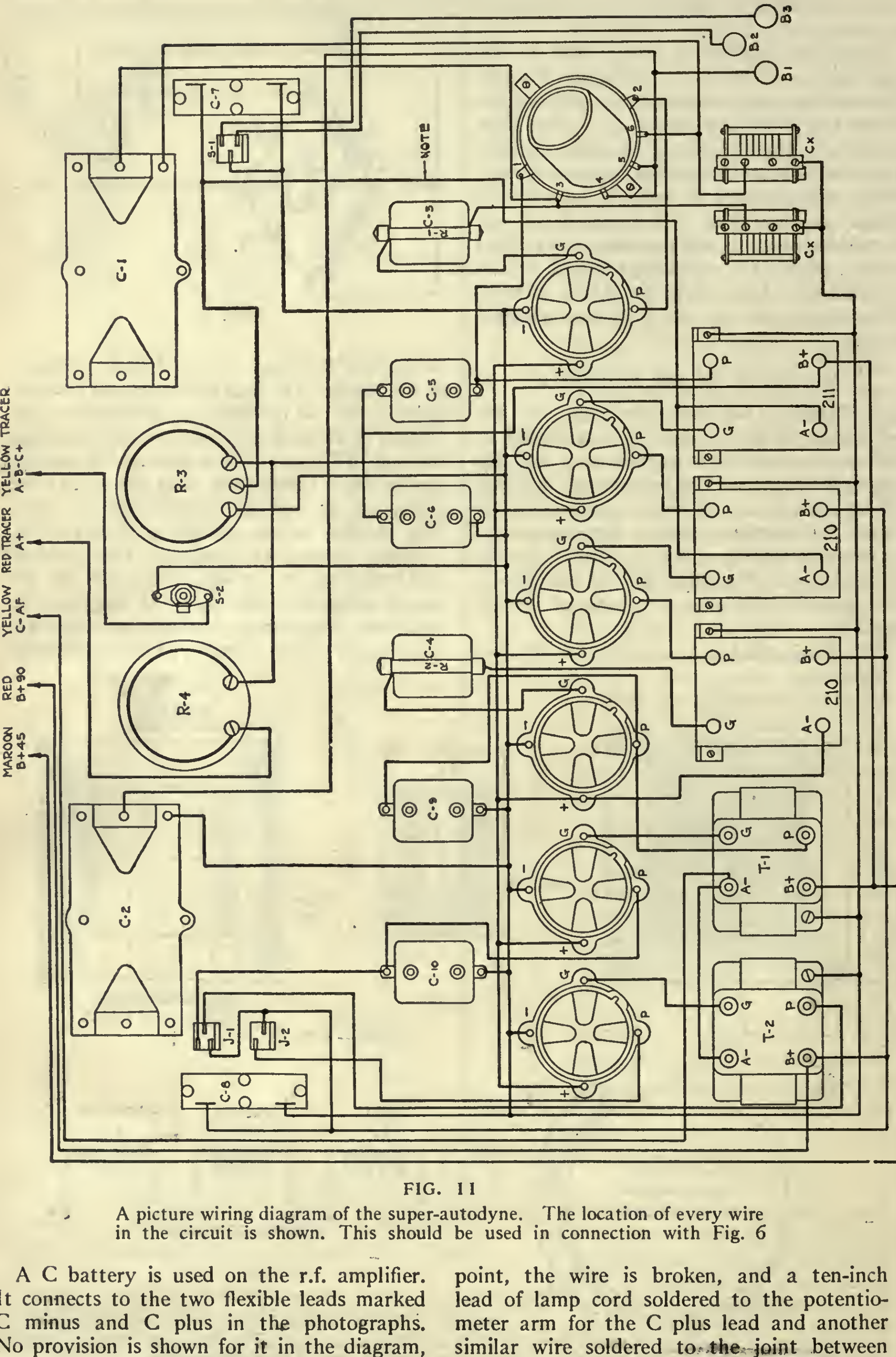


FIG. 11

A picture wiring diagram of the super-autodyne. The location of every wire in the circuit is shown. This should be used in connection with Fig. 6

A C battery is used on the r.f. amplifier. It connects to the two flexible leads marked C minus and C plus in the photographs. No provision is shown for it in the diagram, except the point marked "Note." At this point, the wire is broken, and a ten-inch lead of lamp cord soldered to the potentiometer arm for the C plus lead and another similar wire soldered to the joint between C7 and the A minus lugs of the 211 filter and

its adjacent 210 transformer. This C battery is 3 volts, and may be placed in the cabinet under the sub-shelf, since its leads should be short. It had best be wrapped in paper to prevent shorting on any of the wiring. For UV-201A tubes, these leads may be shorted and the battery eliminated entirely if the amplifier will oscillate without it.

The remaining battery leads are brought out through a color cable, which should be coded in accordance with the data presented on page 1034 of the April RADIO BROADCAST. Unfortunately, there are a few manufacturers who have not yet adopted this coding for their cables. In Fig. 6, the colors of the various wires in the cable used for different voltages are given. This was for one particular make of cord, used on an experimental set. It will be noticed that the black lead with red tracer is used for three connections, which are made between the batteries themselves by means of other wires.

ACCESSORIES AND TESTING

ASSUMING the receiver to have been wired, it is ready for test. The additional material required is as follows:

6 Radiotron tubes, UV-201A, or UV-199. DV-3 De Forest tubes may be substituted for 199's, but will require a standard-base socket shelf.

1 A-battery. This may be a storage battery, 6 volts, 90 ampere hours for UV-201A's, or it may be the battery used in an auto, tapped by means of Lynch Leads. For dry cell tubes, three dry cells may be used, or, better yet, for home installation six in series-parallel.

1 B-battery. For permanent installation 90 volts, of large size 22, or 45 volt batteries should be used. For portable work, $67\frac{1}{2}$ volts will be sufficient, of medium or small-size batteries, since the current drain is but 12 milliamperes for 201A tubes, and 9 milliamperes for 199s. (90 volts will give only slightly more volume than $67\frac{1}{2}$, so it is hardly worth while to carry around the extra 22-volt battery.

2 C-batteries. One 3-volt battery required in the set box for the r.f. amplifier, and one $4\frac{1}{2}$-volt battery for the a.f. amplifier.

1 Loop with center tap. Any good tapped loop may be used, or one may be made by winding 16 turns spirally on a form about 24 inches square, tapped at the center, with $\frac{1}{4}$ inches between turns. This loop with eighteen turns, $\frac{3}{16}$ inches apart, may be wound on the back of a cabinet large enough to hold the set, with the batteries beneath if desired.

1 Loud speaker. The small Amplion is recommended for portable work as it is a most excellent speaker, and delivers very good volume and quality. For home use, the Western Electric cone speaker is best, with its leads shunted by a .0075 mfd. condenser.

1 Phone plug.

1 Set Lynch Leads if the set is to be operated in a car, using the starting and lighting battery. The Lynch Lead may be made up from any double conductor wire. Several types of wire can be used, but the flexible, rubber covered lead is recommended. The wires, which should be colored for ease in identification, should be scraped on one end, for connection to the filament posts on the receiver. The other end of the lead should be connected to a plug which will fit into the dashboard connection to the automobile storage battery.

1 7 inch x 18 inch x 7 inch mahogany cabinet.

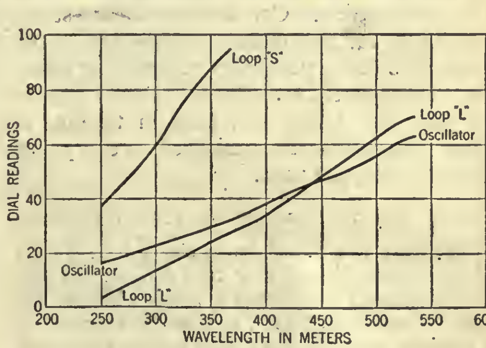


FIG. 12

Typical tuning chart of a super-autodyne. The curve marked "Loop S" is for the loop condenser with the switch in the "L" position. Only one curve is shown for the oscillator. The curve embracing the upper heterodyne points would parallel the one given, starting about four degrees higher at 250 meters and ending about thirty degrees higher at 530 or 540 meters

CONNECTIONS

THE A battery should be connected to its leads, one tube inserted in a socket, switch S2 closed, and rheostat R4 just turned on. If the tube lights, it should be moved from socket to socket to see that all A connections are correct. The positive battery lead should then be connected to the B45 and B 90 posts. If the tube lights, the wiring or assembly is faulty and should be checked. The tube should only light when the A battery is connected to the A leads.

The remaining batteries may be connected, and the loop leads run to posts B1, B2, and B3. If the loop is spiral, B1 goes to the outside

lead, B2 to the center and B3 to the inside. When switch S1 is to the left, or short position, only half the loop is used. When it is to the right, the whole loop is used. This means all low wave stations up to 380 meters will come in on dial C2 from 0 to 100 degrees. Stations from 350 meters up will come in on C2 with switch S1 thrown to the right, or long position. This means that in the long position, C2 will read about 20 for 345 meter stations, and about 70 for 536 meter stations. On the short position, C2 will read about 85 for 345 meter stations, and about 45 for 270 meter stations. These figures are approximate, but show that to cover the entire wavelength range, C2 must be varied from 0 to 100 degrees to go up to 370 meters with S1 to the left, then S1 turned to the right and the remaining wavelength range secured by varying C2 again from 0 to 100, allowing, of course, for over-lapping. C1, the oscillator, starts around 18 for 270 meters, and brings in the lower heterodyne point for 536 meters at about 70. Two points can be found for each station on this dial, which will help in tuning, as when interference is experienced on one point, the other may be used.

TUNING AND TESTING THE COMPLETED RECEIVER

THE first test should be to check tube V1 for oscillation. Insert only tube V1, set R4 just on and connect the phones in series with the B45 lead. Then touch lugs 3, or 6 of the coupler. If a plucking sound is heard, this tube is oscillating. If not, adjusting the rotor coil will cause it to oscillate. When this rotor winding is in the same plane as the stator windings, turning it 180 degrees around will either start or stop oscillation. When once set to produce oscillation, this coil should never be touched. If the tube squeals at low settings of C1, reduce R1 to .25-megohms, or try another .5 megohm leak. Use the highest value of leak possible—(up to 1 meg). The receiver will probably squeal below 10 degress on C1 in any case. R2 is not critical and may vary from 1 to 3 megohms.

With tube V1 oscillating constantly, insert the remaining tubes in the set, turn the rheostat seven-eighths on for 201A tubes, or on one-third for 199's, and rotate the potentiometer from positive to negative. If both C1 and C2 are set at 100 degrees, a plunk will be heard at some point as R3 is adjusted, indicating amplifier oscillation. If C1 is adjusted, squeals will be heard. R3 should be set with its arm just positive of the point where squeals can be heard, and either left set at this point, or used to control volume. Now, with S1 to the right, and C1 set at 50, rotate C2 over its entire range. A click will be heard near the center of its scale. The condenser CX connected between terminals 3 and 4 of the coupling unit should now be slowly turned out in small steps until rotating C2 fails to produce a click. The receiver is now balanced and CX, CX should never be touched unless tube V1 is changed.

In tuning, C2 will appear rather broad, which is correct, while C1 will be extremely sharp. This permits of extremely easy logging, since C2 need only be set approximately correct, and C1 rotated in order to find a station. The chart printed on page 385 will help in preliminary tuning. The set will log definitely, and a station once heard may be brought in again at the same settings of S1, C1 and C2, providing CX, CX have not been tampered with.

Due to the sensitivity of the circuit, a small amount of hand capacity may be noticeable on C1. This may be overcome by grounding the negative filament line to a piping system, or it may be compensated for by tuning-in a station, increasing C1 slightly until the volume begins to decrease, and removing the hands from the set. The signal will then return to full intensity. It will be evident in those few cases where it may be encountered, only on weak, low wave stations. and is seldom bothersome.

An Explanation

THE similarity in name of Dr. Walter Van Braam Roberts and J. E. Roberts has led to some confusion among the readers of RADIO BROADCAST. Doctor Roberts, of Princeton University, is responsible for the inception and the design of the Roberts Knockout receiver. Doctor Roberts wrote two articles describing this receiver which appeared in the April and May, 1924, RADIO BROADCAST.

Immediately after the publication of these two articles, a great deal of interest was shown by radio constructors all over the country in the design and operation of the set. Many investigators started building the receiver, making additions and alterations according to their own ideas. One of these enthusiasts was J. E. Roberts, of Cleveland, Ohio, who prepared an article describing how to build the original two-tube circuit in a cabinet with an additional stage of audio amplification, making three tubes.

We have received many letters from residents of Cleveland and vicinity who have taken issue with what they regarded as an unfortunate use of the similarity of last names of these two men. The situation which drew the protest was in Cleveland and other cities. And in especial, a number of our correspondents did not like printed matter which was distributed by a Cleveland radio shop.

Mr. J. E. Roberts has no connection with RADIO BROADCAST other than that of a former contributor to its pages. The only approved models of the Roberts Knockout circuit have been described in the magazine. We can take no responsibility for any printed matter or representations of individuals relative to this circuit released by other sources than this magazine except that of approved manufacturers of parts which may be used in the Roberts circuit.

A New Method of Radio Frequency Amplification

The Theory of Various Arrangements for Neutralizing Tube Capacity in Radio-Frequency Amplifier Circuits and a Discussion of a New Method—An Arrangement for the Measurement of Amplification Constant and Impedance

BY C. L. FARRAND

THIS paper of Mr. Farrand's was presented before a meeting of the Radio Club of America, in New York, and involves an interesting history and discussion of neutralizing methods in radio frequency amplification. Toward the end of the paper, the author also describes a method for connecting and using a vacuum tube voltmeter which should be particularly interesting to many readers. In a later number we shall print another article by the same author, dealing with his later investigations. The papers presented before the Radio Club appear from time to time in this magazine. The editor assumes no responsibility for statements made by the authors of the papers, but is very glad indeed to present them to the readers of RADIO BROADCAST.—THE EDITOR

IT IS the purpose of this paper to present a new method of radio frequency amplification, together with the necessary data for the design and construction of the circuits. Tuned radio frequency amplification is not new. See Schloemilch and Von Bronk, United States Patent No. 1,087,982. This method has been used with considerable success, more difficulty being experienced as the number of stages were increased. These difficulties were due to incipient couplings in the amplifier circuits, either between the input and output circuits of a single tube or between the input and output circuits of more than one tube. These couplings are either electro-magnetic or electro-static, as in a good design, resistance couplings are eliminated. The magnetic couplings can best be taken care of by disposing the transformer windings so that their axes are at right angles, and on the same center line, with reasonable distance between windings.

Static couplings between the input and output circuits of the tubes can be eliminated by shielding in all cases excepting the inherent capacity coupling of the tube itself. From general considerations it is apparent, having been brought out before, that there are three capacities in a three-electrode vacuum tube, two of which act in shunt to the input and output circuits respectively, and the third which is the grid to plate capacity, acts as a coupling between the input and output circuits. See Fig. 1. To eliminate this coupling, it is necessary to resort to balancing arrangements or to additonal circuits which will nullify the influence of the coupling current flowing through this capacity. The coupling increases with frequency, and, it is in the broadcasting range and shorter waves that the most difficulty is experienced.

Various methods have been suggested for neutralizing or balancing the tube coupling. Hartley (R. V. L. Hartley, United States Patent No. 1,183,875) has suggested a magnetic balance, which is the equivalent to a reverse tickler coil. See Fig. 2.

By this method, the coupling effect of the grid-to-plate capacity of the tube is balanced by an equal and opposite magnetic coupling between the input and output circuits. This condition holds for only one wavelength. In the Figure shown, the static tube-coupling increases with frequency, while the magnetic coupling remains constant.

THE RICE METHOD

RICE (C. W. Rice, United States Patent No. 1,334,118) has suggested a capacity balance which is in effect Fig. 3. By this method, the coupling effect of the grid-to-plate capacity is balanced by a capacity of equal value connected between the plate and an input coil being opposite potential to the grid.

Hazeltine (L. A. Hazeltine, United States Patent No. 1,450,080) has suggested a

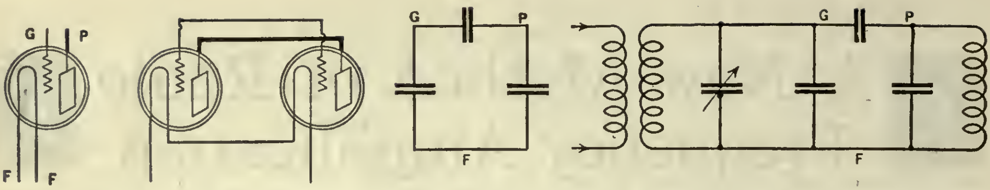


FIG. 1

capacity balance wherein the effect of the grid to plate capacity of the tube is balanced by means of an output transformer. Fig. 4.

Here the coupling effect of the grid-to-plate capacity is balanced by a capacity connected between the grid and an output coil having a potential opposite to the plate.

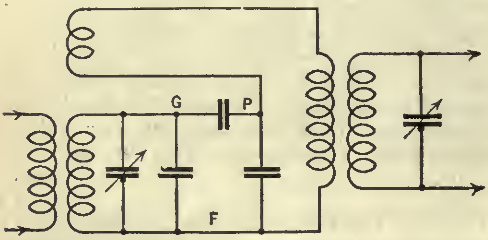


FIG. 2

The output coil is the secondary of the transformer supplying the next tube and has a ratio of turns greater than unity to satisfy the impedance relation, so that it is necessary that the value of the balancing capacity be chosen to equal the grid-to-plate capacity divided by the voltage ratio of the output transformer.

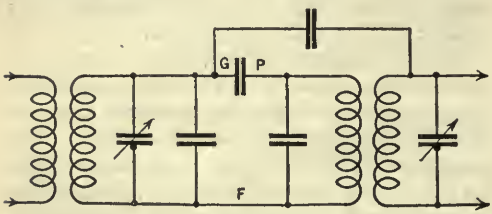


FIG. 3

The disadvantages of the above methods are that, particularly on short wavelengths, it is very difficult to maintain a balance when more than one stage of radio frequency amplification is used. This is due to stray capacities, which tend to upset the balance of the circuit. Oscillations then result. Difficulty of this sort is also brought about by the variation of grid-to-plate capacity of commercial tubes, which vary so much that a balance obtained for one tube may not hold for another.

A NEW NEUTRALIZING SCHEME

THE method of nullifying the effect of the grid-to-plate capacity of three-electrode vacuum tubes described in this paper does not depend upon a capacity balance and is free from the disturbing effects described above. The method involves a resistance connected between the grid and plate of the tube as in Fig. 5.

The effect of this arrangement is to change the phase of the coupling current flowing between the input and output circuits, thereby reducing the energy transfer or feed-back between these circuits and causes the remaining energy to be absorbed as quickly as it is transferred or fed back. The value of resistance necessary to nullify the grid-to-plate coupling is dependent upon the design of the tube, as

FIG. 4

well as the circuits. This resistance value is not critical. For the storage battery tubes now in commercial production, a resistance ranging between twenty-five and thirty-five thousand ohms gives satisfactory performance for multistage operation. The value for multistage operation is slightly lower as it is possible to take care of the stray overall coupling by a slight reduction of resistance. One hundred thousand ohms is a satisfactory value for the present dry cell tubes and may vary between ninety and one hundred and twenty thousand ohms.

The resistance should preferably be non-inductive and of low capacity. Present forms of conducting coated-paper resistances, and

carbon filament wound lavite resistances are satisfactory.

The circuit for a two-stage amplifier is shown in Fig. 6.

It will be noted that a condenser is inserted in series with the resistance between grid and plate to prevent the plate battery from flowing through it to filament. The condenser is purely a blocking condenser and may range in value between one microfarad and one one-thousandth of a microfarad, and is only needed to permit the amplifier tubes to be operated from a common plate battery.

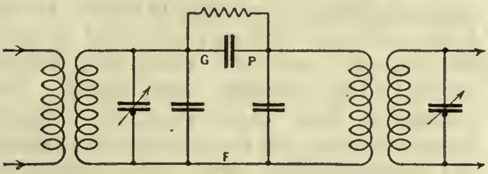


FIG. 5

The transformer windings should preferably be tightly coupled, although this is not necessary as long as a suitable voltage ratio is maintained between primary and secondary. A suitable design consists of one hundred turns of No. 26 B & S gauge wire on a cylindrical tube, two inches in diameter and about two and three quarter inches in length. This is the secondary winding. The primary should be wound with about twenty-five turns of the same size wire on a concentric cylindrical tube of about one and three quarter inches in diameter. It is preferable to have the primary winding the same length as the secondary winding is when enclosed by the seconary winding. This arrangement gives the tightest coupling, although the same result may be secured by using more primary turns and less coupling. This will be discussed more in detail later. The primary is, in practice, wound opposite to the secondary. That is to say, if the secondary is wound clockwise, the primary is wound counterclockwise, or vice versa. The end of the primary winding directly under the grid end of the secondary should be connected to the plate battery. The other terminals follow as usual. The secondary tuning condenser should have a capacity of approximately two hundred and fifty micro-microfarads. The increase in intensity produced by each stage of radio frequency amplification as outlined above is nearly as much as that produced by each stage of audio frequency amplification. This is a very general statement but holds fairly closely for radio stages up to three or four before the detector when compared one stage at a time with one and two stage of audio after the detector, although the voltage amplification of the radio stages were only about twelve each while the audio amplifiers gave approximately twenty per stage.

This indicates that while the detector characteristic is not linear it is far from a square law.

REGENERATIVE AMPLIFICATION IN THIS CIRCUIT

IN ADDITION to the radio frequency amplification of each stage, it is possible to obtain a regenerative amplification which is equivalent in increased volume to the addition of two audio stages on a signal of average intensity. Fig. 7 shows the circuit of a receiver consisting of three stages of radio frequency amplification, a detector and two audio stages.

The regeneration here shown is provided for by omitting the nullifying resistance of the third radio stage, and controlling the feed-back due to the tube coupling by means of a potentiometer on the grid of this same

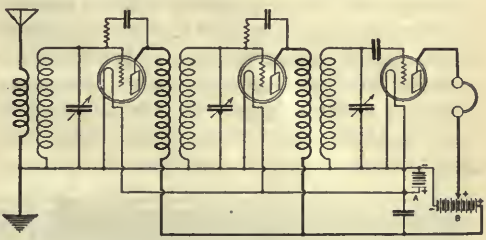


FIG. 6

tube. This gives very satisfactory operation. Equally satisfactory operation may be had by the use of a variometer in the plate of the detector tube in the usual manner. In this case the nullifying resistance must be used across the grid and plate of the third tube as well as across the first and second. In the use of three stages of radio frequency amplification without regeneration it is not necessary to take any particular precautions except to dispose the transformer windings at right angles and to use care to provide for short grid leads, and that the grid lead of one tube does not run close to the grid lead of another tube. If such precautions are not taken, the amplifier may regenerate and oscillate at the lower wavelengths. It will be found that when the regenerative feature is added to the amplifier or detector, better control of the regeneration will be obtained if the receiver

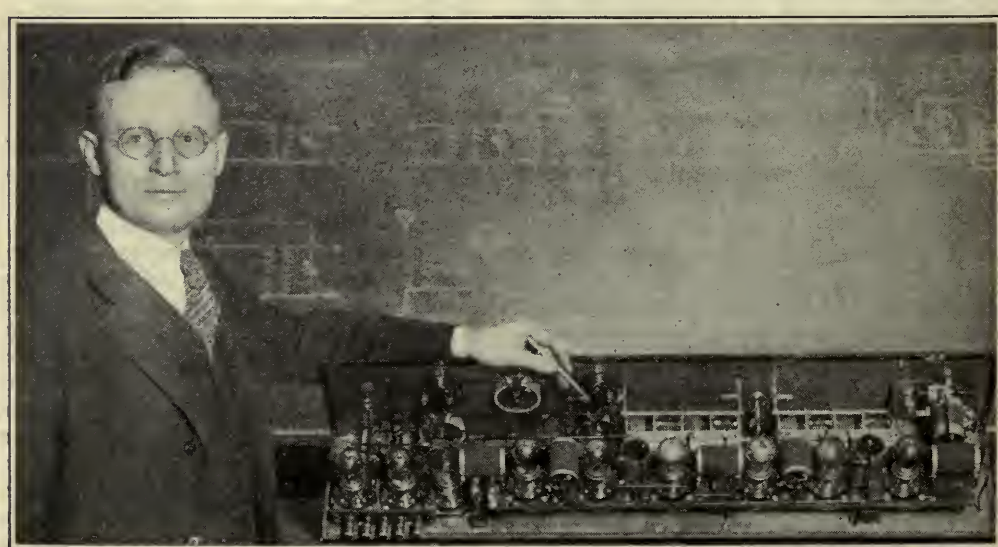
has first operated satisfactorily without regeneration. This means that the interstage coupling has been reduced to a minimum and that this provides for the localization and better control of the regeneration. In the operation of a receiver as outlined above using two or three stages of radio frequency amplification in addition to regeneration, the local oscillations produced during the adjustment of the regenerative amplifier or detector tube do not radiate from the antenna in any noticeable degree sufficient to cause interference with near-by receivers. As a typical example of this, a receiver has been operated on an outdoor antenna approximately forty feet from an adjacent antenna which is paralleled for approximately twenty feet. Both antennas were approximately forty feet high and had a total length of about one hundred and twenty five feet. The beat produced by the receiver was noticeable on the receiver of the adjacent antenna only on reception from stations nearly one thousand miles distant and then was not particularly objectionable.

Due to the low input impedance of the present commercially produced tubes and the consequently large damping effect produced thereby, the tuning of transformers is broader than would be anticipated. While objectionable in single-stage operation, the tuning sharpens considerably with the addition of several stages until very reasonable selectivity is obtained. It is also possible and extremely practicable to tune the transformers by means of condensers on a common shaft as suggested by Hogan. (J. V. L. Hogan, United States Patent No. 1,014,002). This has been done very successfully with three stages of radio frequency amplification using an aperiodic antenna input by means of four condensers on a common shaft and with six stages of radio frequency amplification by means of eight condensers on a common shaft. In the latter case one condenser was used to tune the antenna separately which was loosely coupled to the amplifier input circuit. The condensers were electro-statically shielded from each other, and the tube coupling capacities were nullified by means of the resistances of values given above.

Additional improvements in selectivity have been made, which, unfortunately cannot be disclosed at the present time and will have to form the subject of a later paper. It might be mentioned that by these means, reception without regeneration of five hundred and nine-meter stations in Philadelphia, through a local four hundred and ninety two-meter station, is entirely practicable.

MEASUREMENTS OF AMPLIFICATION CONSTANT AND IMPEDANCE

A METHOD of measuring the voltage amplification of radio-frequency amplifiers during the writer's experiments became very desirable. After various methods were



MR. FARRAND DEMONSTRATING HIS RECEIVER

Before a meeting of the Radio Club of America in New York. The entire back of the panel is shielded, as can be seen from the photograph. The condensers are all tuned by one knob which controls a gear arrangement. Nine tubes are used in this model

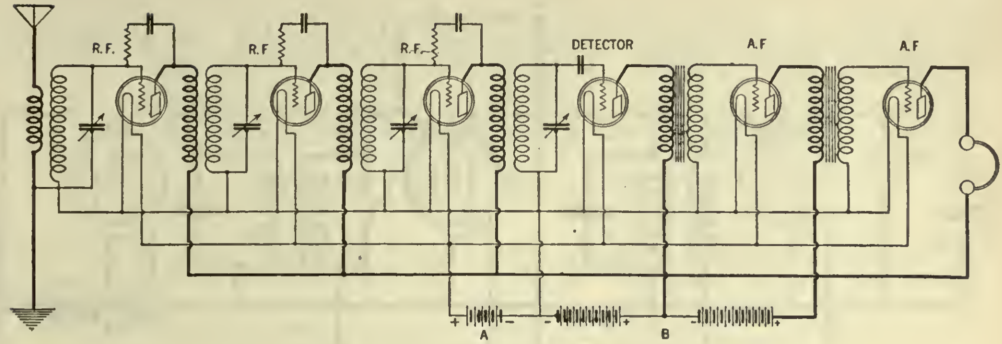


FIG. 7

considered and used, the peak volt-meter was selected as giving most promise. This method consisted in determining the actual voltages of the grids under working conditions by use of a three-electrode vacuum tube. The use of three-electrode tubes as volt meters is well known and has been described before.

The voltmeter was calibrated as follows: A UV-201A tube was used with approximately 67 volts on the plate and about 12 volts negative on the grid. The plate current was then normally about 10 micro-amperes. A known radio frequency voltage was applied to the grid and the grid negative voltage was increased until the plate current reached a known value which was the 10 micro-amperes. The increment of negative grid voltage was recorded. It was found that the tube would always reproduce these conditions with the same voltages. In this manner the voltmeter was calibrated in terms of increments of negative grid voltages vs. applied root mean square values. To save interpolation the measurements of impedance and voltage amplification were made with the same r.m.s. value of voltage applied to the voltmeter. This value was set at .5 volts and the input voltage of the preceding tube changed until this value was produced.

The following is a diagram of the voltmeter and circuit used for these measurements:

The capacity of the voltmeter is very small, since it is only the grid-to-filament capacity of the tube plus small lead capacity which would approximate 10 to 20 micro-micro-farads. This capacity is connected in parallel to the tuning condenser and therefore does not affect the result. The impedance of the voltmeter can be considered as purely resistance in nature and very high, probably several megohms, as the grid has in excess of 10 volts negative applied.

MEASUREMENTS WITH THE VACUUM TUBE VOLTMETER

THE voltage amplification per stage is the voltage of the grid of the second tube divided by the voltage of the first tube. It was necessary to determine that the impedance of the plate circuit of the second tube would not affect the impedance of its grid, as in multistage operation the plate circuit of the second tube would be tuned by a transformer to supply the grid of the succeeding tube, and if this high impedance caused by the plate tuning of the second tube affected its grid to filament impedance, the measurement as outlined would not hold. Non-inductive resistances of 10,000 ohms were inserted in the plate circuit and the plate voltage was maintained constant by adding sufficient battery to take care of the resistance drop, and at radio frequencies this was found to affect the input impedance of the grid very considerably. This corresponded somewhat to the results obtained by Weinberger. (J. Weinberger, *Proc. I. R. E.*, page 584, sec. 1919.) It was thought that this change of impedance might be due solely to capacity coupling of the tube causing feed-back action, therefore the applied frequency was reduced to 1000 cycles and it was found that at this frequency, the grid-to-filament impedance was independent of the plate load impedance. It followed, therefore, that any influence of the plate load on the grid impedance was due to regeneration and would disappear when the regeneration was nullified.

The measurements of voltage ratio by this method would hold and give the true radio frequency amplification without feed-back as long as the amplifier was non-regenerative.

The voltage ratio was determined for a tuned radio-frequency transformer as shown in the Figure and the radio frequency ampli-

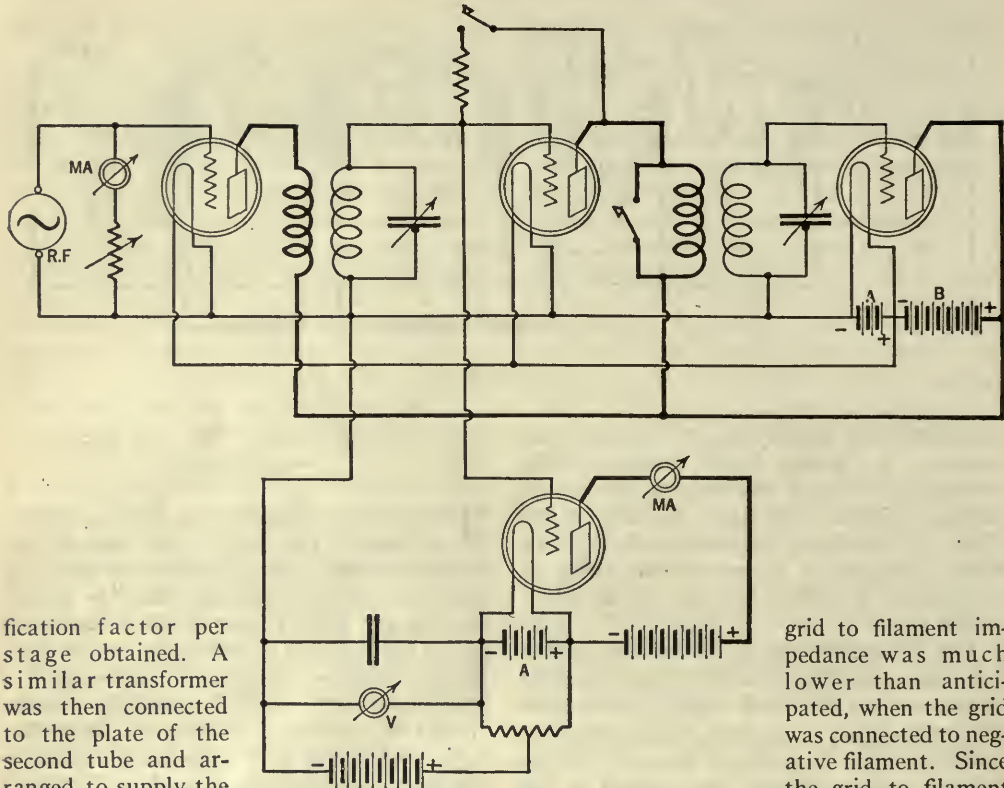


FIG. 8

fication factor per stage obtained. A similar transformer was then connected to the plate of the second tube and arranged to supply the grid-to-filament circuit of a third tube which was connected as the second tube had been in the first case. The voltage on the grid of the second tube was found to be decidedly higher due to feed-back action. A nullifying resistance was then connected from grid to plate of the second tube and adjusted until the voltage of its grid equalled the original voltage as given when the output of the plate was shorted by switch "S." The resistance had then nullified the feed-back action due to the natural capacity between the grid and plate of the tube and the voltage amplification obtained was the original non-regenerative radio frequency amplification. The value of nullifying resistance thus obtained was found to be between 30,000 and 50,000 ohms for UV-201A tubes and between 80,000 and 120,000 ohms for UV-199 and WD-11 tubes The values of resistance approximate the capacity coupling reactance of the tubes, i. e., the grid to plate capacity in ohms at the operating frequency.

IMPEDANCE VALUES OF COMMERCIAL TUBES

THE maximum voltage amplification determined and the turn ratios for maximum amplification lead to the conclusion that the grid to filament impedance was much lower than anticipated, when the grid was connected to negative filament. Since the grid to-filament impedance was always shunted with a secondary tuning condenser, it could be considered as purely resistance in nature. It was decided to determine this impedance value for commercial tubes. The peak voltmeter method was very well suited to this measurement as it was only necessary to substitute a known non-inductive resistance for the tube, retune to compensate for the reduction of capacity of the grid-to-filament and adjust the resistance until the voltage of the grid of the second tube was at its original value. The resistance thus determined was then equal to the resistance of the grid-to-filament path of the tube. These values for UV-201A tubes with grid connected to negative filament were found to be between 120,000 and 150,000 ohms with 130,000 ohms as a fair average. This accounted for the broadness of tuning of non-regenerative radio-frequency amplifiers, as with a circuit using a condenser of 250 micro-microfarads maximum, for the broadcasting range, the condenser reactance at 400 meters is approximately 1800 ohms and the effect of 130,000 ohms in shunt to such a circuit is the same as if approximately 25 ohms had been inserted in series with the condenser and inductance, and consequently produces very large damping.

How to Build Radio Broadcast's Phonograph Receiver

By ARTHUR H. LYNCH

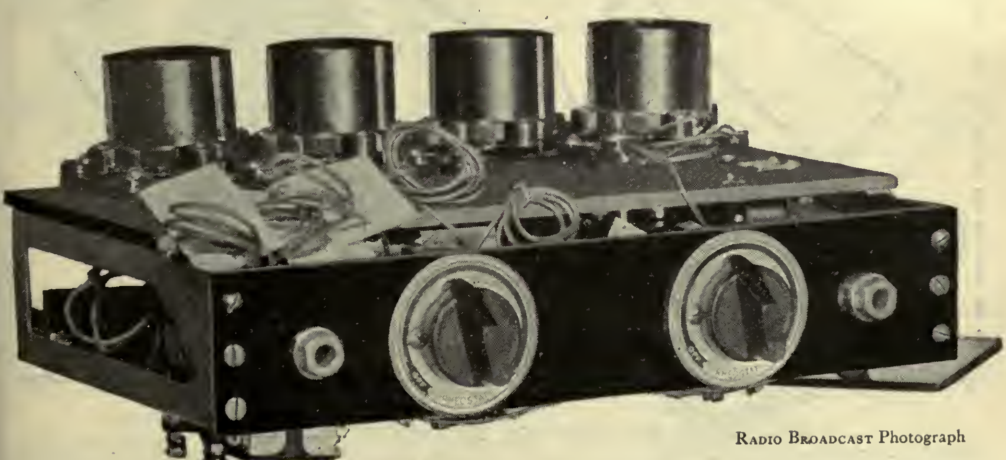
IN THE June Radio Broadcast we described a receiver which has been designed to fit in any phonograph. This article, the second of the series describing this receiver, deals with the actual construction of the apparatus and indicates by illustrations what has been done in Radio Broadcast's Laboratory to apply this unit to a number of phonographs.

It may be seen from the illustrations accompanying this article, that it is not necessary to use one specified unit in building this receiver. For example, any good audio transformer will function satisfactorily in the reflex stage, and any good push-pull transformer will work in the amplifier arrangement. In the diagrams shown in Figures 23-A and B, the panel and sub-base arrangements have been designed to accommodate practically any .0005 mfd. condenser, and almost any tube sockets and other units which make up the assemblage.

Radio Broadcast's Phonograph Receiver has not been designed to satisfy the demand for the ultimate in radio reception. It will, however, bring in excellent quality with very good volume and at the same time cover a very reasonable wavelength range. With a similar set operated here on Long Island during the month of April, and using but two tubes, the following log was made in one hour and twenty minutes:

DIAL SETTINGS	CALL LETTERS
12–12	WCAD
15–15	WEAN
19–19	WTAS, WPG
21–21	KDKA
22–22	WGBS
28–28	WLS
31–31	CFCA
32–32	WHN
34–34	WGN
39–39	WTAM
41–41	WLIT
42–42	WOR
45–45	CHYC
46–46	PWX
49–49	WLW
52–52	WOS
57–57	WJZ
60–60	WCAE
62–62	WCAP
64–64	WEEI
69–69	WEAF
80–80	WNYC

When this log was made, the set was tuned with but two controls. The rheostat and



Radio Broadcast Photograph

FIG. 1. SUB-PANEL ASSEMBLY

The photograph illustrates how the rheostat panel and tube sockets are mounted upon the brackets. All connecting leads to the main panel are temporarily coiled and labeled until this assembly is ready for further use This is the "Robert-Unit" made by the Radio Research Laboratories

tickler controls were not used. It will be noted that the positions of the two dials throughout this log coincide over the entire broadcast range.

HOW TO ASSEMBLE AND WIRE THE SUB-PANEL

BEFORE drilling holes in the sub-panel for mounting the various units it must hold, it is advisable to place the sub-panel itself upon the brackets which are going to support it on the main panel. Then place the tube sockets in their proper places and if necessary, secure them with a few pieces of string. Then turn the sub-panel upside down and mark off the positions to be occupied by the transformers, but make certain that there is plenty of space surrounding each unit to permit the wiring to be done easily.

It is good practise to do as much wiring on the sub-panel as possible before permanently attaching it to the panel as shown in Fig. 1.

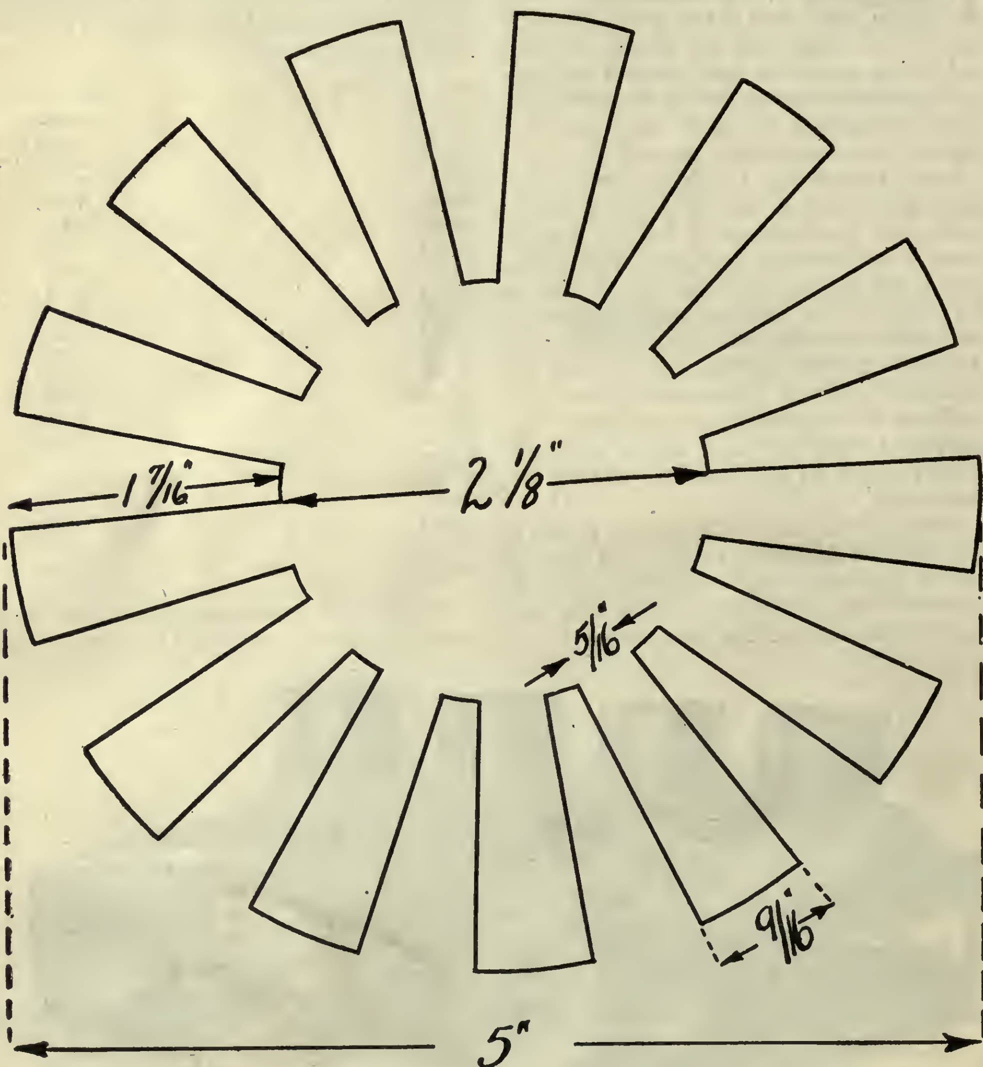
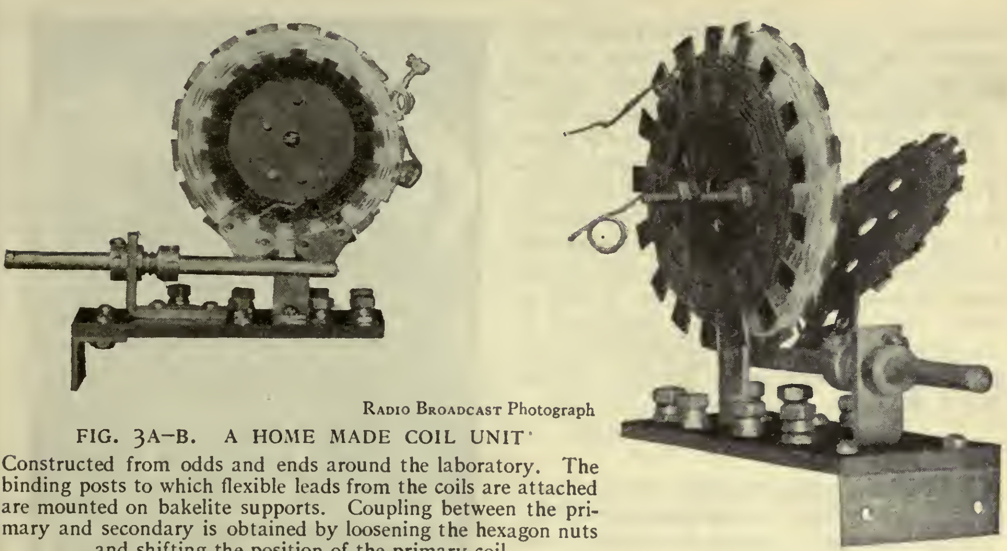


FIG. 2. A TEMPLATE FOR THE SPIDER WEB COILS

Exact size. The windings for these coils, as used in various parts of the Roberts circuit and indicated by the letters are as follows: A (antenna coil): 40 turns No. 22 DCC wire tapped 1–2–5–10–20–30–40; S1: 44 turns No. 22 DCC wire; N: 20 turns No. 26 DCC wire; P: 20 turns No. 26 DCC wire (two wires of N and P are wound parallel as a pair); S2: 44 turns No. 22 DCC wire; T: 18 turns No. 22 DCC wire. Coils A, S1, S2 and T are each individually wound under two and over two spokes of the form. The NP coil is wound under one and over one spoke



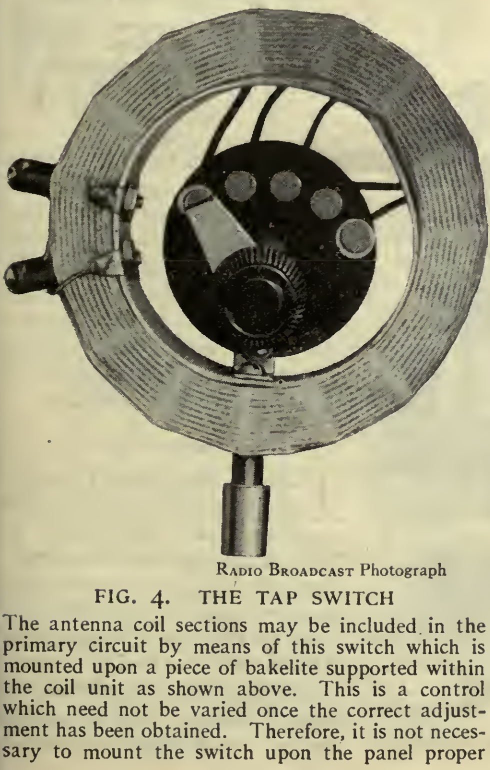
RADIO BROADCAST Photograph

FIG. 3A–B. A HOME MADE COIL UNIT

Constructed from odds and ends around the laboratory. The binding posts to which flexible leads from the coils are attached are mounted on bakelite supports. Coupling between the primary and secondary is obtained by loosening the hexagon nuts and shifting the position of the primary coil

THE PANEL

IN ARRANGING the units on the panel the layouts in Figs. 21-A and B will be found very helpful. Then, too, it is good practise to wire as much of the panel as possible before the sub-panel is attached. If this plan is followed the balance of the wiring will be brought to a minimum and the attendant work will be much simplified.



RADIO BROADCAST Photograph

FIG. 4. THE TAP SWITCH

The antenna coil sections may be included in the primary circuit by means of this switch which is mounted upon a piece of bakelite supported within the coil unit as shown above. This is a control which need not be varied once the correct adjustment has been obtained. Therefore, it is not necessary to mount the switch upon the panel proper

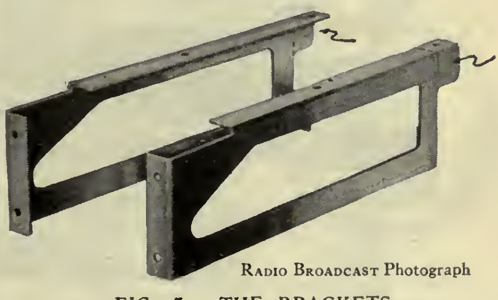
HOME-MADE COILS

ONE of the simplest forms of coil for home construction and which may be used in this receiver is the spider-web coil. The form dimensions are given in Fig. 2. The various wire sizes, and the number of turns to be wound on each coil are indicated in the caption of Fig. 2 on page 394.

A simple and good method of mounting and coupling home made coils has been designed by John B. Brennan, Technical Editor of RADIO BROADCAST. This system is illustrated in Fig. 3A-B.

ANTENNA SWITCH

IN ORDER to compensate for the use of antennas of various lengths, a switch is placed in the antenna circuit to alter the



RADIO BROADCAST Photograph

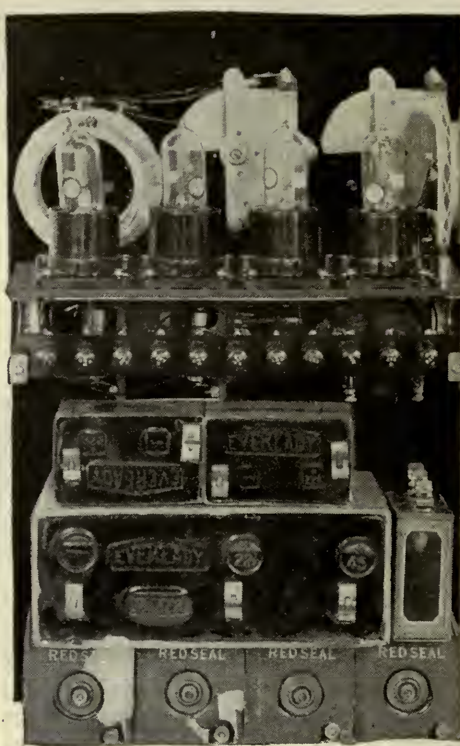
FIG. 5. THE BRACKETS

For supporting the sub-panel upon which is mounted the transformer, etc. The arrows indicate the points at which the projected parts of the brackets are removed

number of turns in the primary of the antenna coupler. By the proper adjustment of this switch, the two main control dials, the antenna and the radio-frequency tuning dials, will be found to read approximately the same for given stations within the tuning range. This feature is particularly valuable when the receiver is used by an inexperienced person. In order to make the layout of our phonograph model more symmetrical we have placed this switch behind the panel as shown in Fig. 4. When the receiver has been completed it should be tested before it is placed in its cabinet and the proper setting for the antenna switch should be determined.

RUBBER BUSHINGS

WHERE cushion sockets are not used, sponge rubber, which may be procured from many dealers, or from several radio mail order houses or rubber companies, is ideal for cushioning the tubes to prevent microphonic noises which are sometimes noticed where rigid construction is used. Flexible wiring is employed between the main and the sub-panels. This is necessary to insure the success of the cushioning. An ideal system for applying bushings of this kind is shown in Fig. 6.



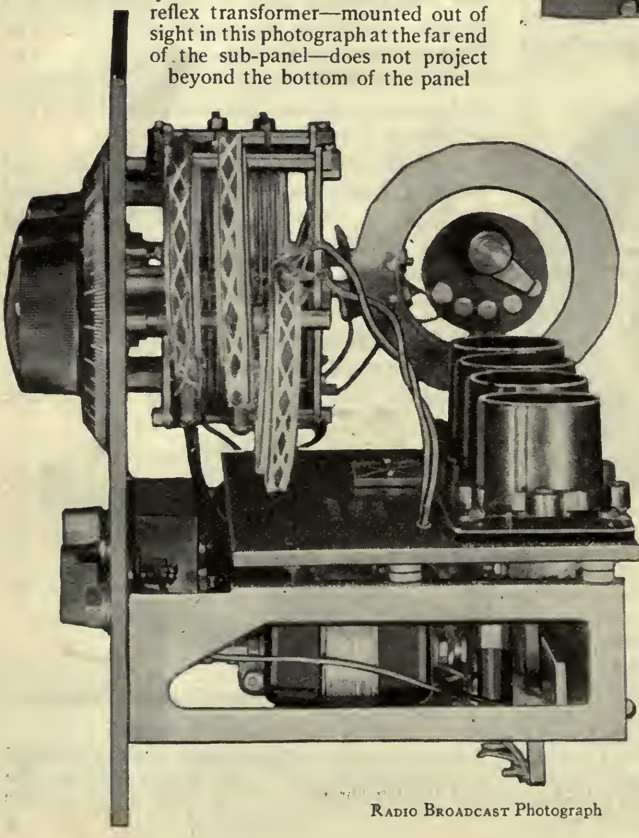
Radio Broadcast Photograph

FIG. 7. THE BATTERIES

Are here shown stacked up to fit underneath the sub-panel. This receiver may be used as a portable outfit. $1\frac{1}{2}$-volt dry cell tubes are used

FIG. 6. THE BUSHINGS

Note that the sub-panel is raised up from the brackets by means of the knurled nuts taken from the socket terminals and which are used as bushings. This is necessary so that the bottom of the audio reflex transformer—mounted out of sight in this photograph at the far end of the sub-panel—does not project beyond the bottom of the panel



Radio Broadcast Photograph

TUBE IRREGULARITIES

TUBES, particularly those which have been in use for some time, are often found to be anything but uniform in performance. A tube which may do very well as a radio or audio amplifier may not function properly as a detector and vice versa. Therefore, the tubes must be tried in various positions until the best combination is found.

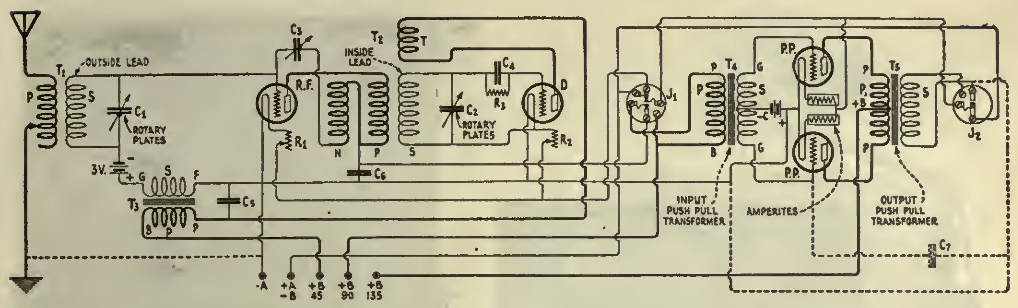


FIG. 8. THE WIRING ARRANGEMENT

From this circuit it will be seen that the push-pull amplifier circuit differs from the original four-tube hook-up. The balance of the circuit, however, remains the same. In this illustration Amperites have been substituted for the rheostat controlling the two push-pull tubes. Also a condenser C7 has been added in the circuit. This condenser will effectively prevent the amplifying transformer from singing

ABOUT PLATE AND GRID VOLTAGES

THE plate voltage on the radio and audio-amplifier tubes is not critical and for practical purposes in the home we have found 90 volts to be ideal. It is unnecessary, unless great volume is required, to use more than 90 volts in any part of the circuit, and it has been found that a jumper between the two last terminals on the binding post strip, as indicated by the dotted line in Fig. 10-A, serves to

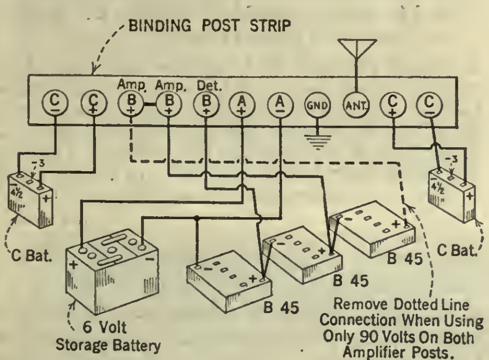
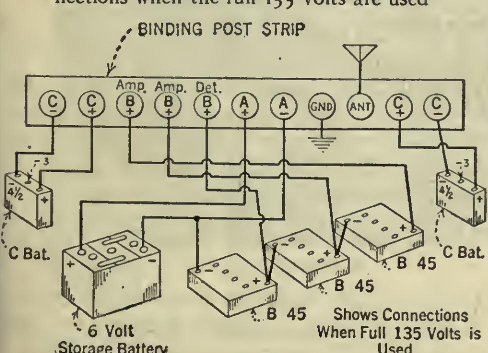


FIG. 10A–B THE JUMPER CONNECTION

When it is desired to use but 90 volts upon the amplifier tubes the connections to the B batteries must be changed as shown in Fig. 10-A. The connection represented by the dotted line is removed and a jumper connection is fastened between the amplifier B plus binding posts. Fig. 10-B shows the connections when the full 135 volts are used



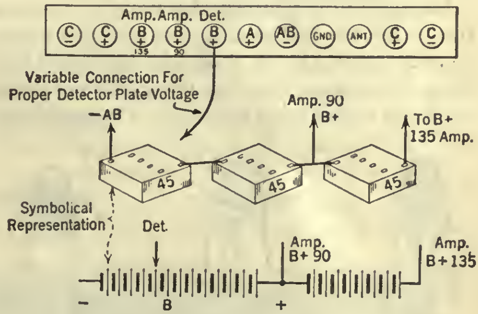


FIG. 9. TESTING PLATE VOLTAGE

For some detector tubes it is necessary to employ a definite plate voltage which must be ascertained by actual test. The pointed lead attached to the B plus binding post may be touched upon the several taps of the first 45 volt B Battery until the desired value of plate voltage is obtained

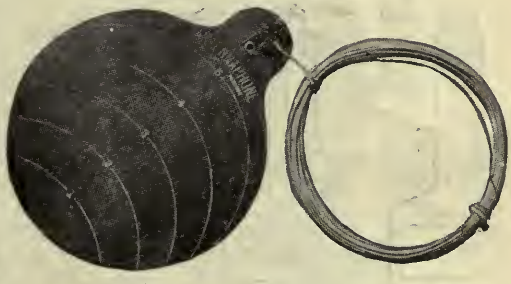
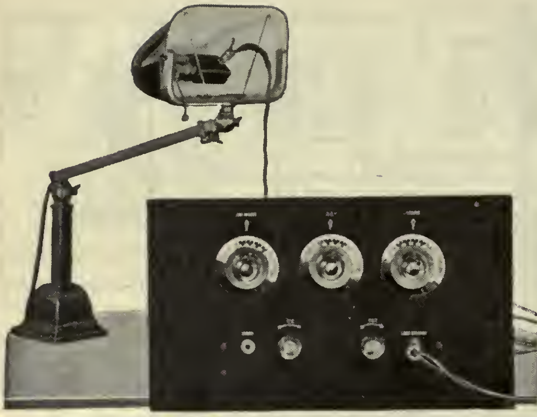


FIG. 11. ANTENNA SUBSTITUTE

For an outside antenna called the Antennaphone. It is only necessary to place a metal disc under a desk telephone to obtain an antenna installation. The disc is then connected to the antenna binding post on the receiver. Wire is supplied for this purpose



RADIO BROADCAST Photograph

FIG. 12. ANOTHER ANTENNA SUBSTITUTE

This unit is merely plugged in to any electric light lamp socket. Several methods of use are shown in Fig. 13

bring this voltage into play on all tubes but the detector.

Caution: When using the jumper between the terminals in the diagrams marked minus 90 and minus 135, as indicated by the dotted lines, make sure that the 135-volt connection to the B battery is taken off. Otherwise the

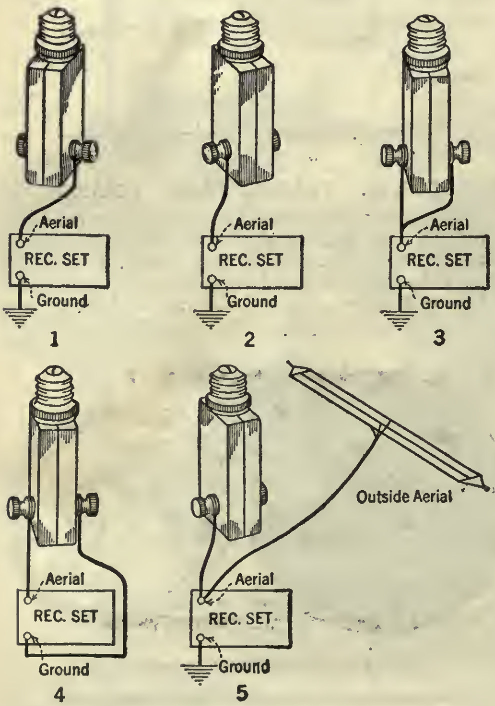


FIG. 13

The several ways in which the Ducon lamp-socket antenna may be connected to the receiver.

RADIO BROADCAST Photograph

FIG. 14. AN ELABORATE PIECE OF RADIO FURNITURE

A Jewett Highboy loud speaker-radio cabinet in which has been combined a loud speaker, a battery cabinet and receiver housing. The sliding doors have been so arranged that any standard-sized receiver may be fitted within the housing. There is still ample room for the installation of a home-made or portable phonograph

last section of the battery will be ruined. This is also shown in Fig. 10-A.

The regeneration of volume of this receiver must be controlled smoothly, and we have found that much depends on the type of detector tube used. The 45 volts indicated in the diagrams is a very flexible standard, and various voltages from 8 to 90 have been employed successfully with various tubes. The detector connection in Fig. 9 is therefore variable.

CENTER HOLES ONLY

TEMPLATES for drilling accompany all modern parts, and to avoid giving the impression that particular units must be employed, we have merely indicated the center holes for condensers, coils, rheostats, jacks and the filament switch mounting in the panel-layouts.

MAKING A PORTABLE OF THE RADIO BROADCAST PHONOGRAPH RECEIVER

IN FIG. 7, we illustrate a receiver which was made to fit in a console phonograph. By removing the entire unit from the console

FIG. 15. A STANDARD FORM OF RADIO—PHONOGRAPH

In this cabinet, manufactured by the Sonora Phonograph Company, has been built a Roberts four-tube receiver. The compartment underneath the receiver contains all the necessary batteries for its operation

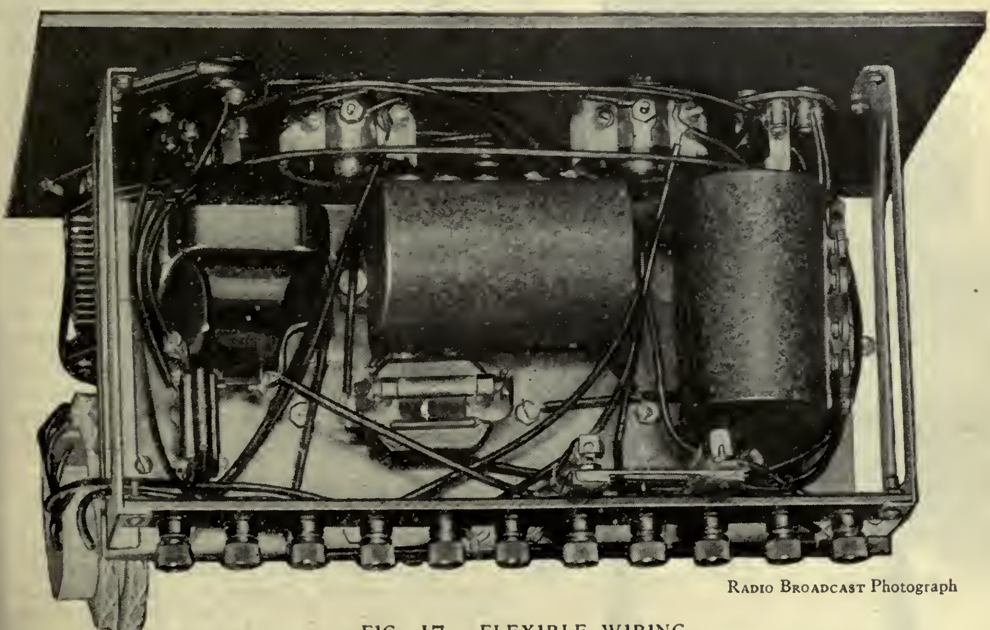
FIG. 16

The rear view of the Sonora cabinet illustrating the ample space which has been provided for the installation of even larger types of storage B battery. The removable back-panel is shown at the right of the main cabinet

Radio Broadcast Photograph

and placing it in a wooden carrying case, or other container, and using dry cell tubes we have an ideal portable for use on automobile trips, boat rides, and other summer activities.

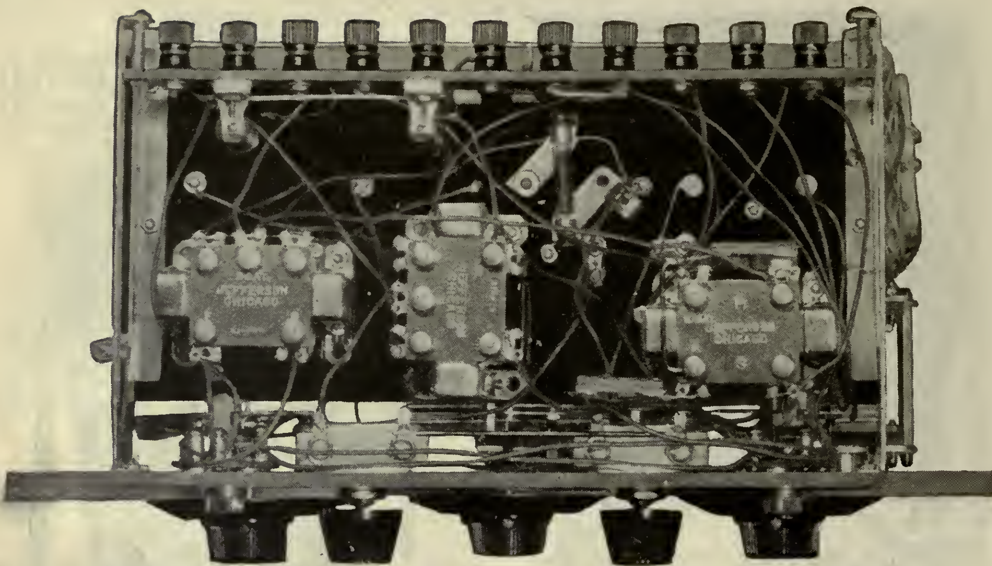
For use of this sort we have found that WD-12 tubes are very satisfactory and that either three or four standard dry cells connected in parallel work very nicely. If the receiver is not to be used as a portable for more than a few weeks, three dry cells will suffice, but for periods longer than a month



Radio Broadcast Photograph

FIG. 17. FLEXIBLE WIRING

A receiver employing the new type of Como push-pull amplifying transformers. It will be seen from the photograph that direct wiring has been employed to connect the various units



Radio Broadcast Photograph

FIG. 18. THE SUB-PANEL

Another view of the bottom of the sub-panel illustrating the use of Jefferson push-pull transformers. The same make of audio transformer has been employed for the audio-reflex stage

we recommend the use of four cells. The connections are shown in Fig. 10–B. The plate current drain with dry cell tubes is very low and for this reason the very small B batteries may be used. When operating the receiver about two hours a day, these batteries will last a month or more. There is room enough for the sky-scraper type, however, and they will last much longer and are more worth-while where weight is not the primary consideration.

THE SUMMER TIME ANTENNA

THERE are many methods for the provision of antenna for use with this receiver in the open. No doubt there is a good market for an antenna made in the form of a reel, similar to a fishing reel. Several antenna reels have been brought to us in an unfinished condition, but we know of none now on the market. This type of radio specialty offers a very attractive field, and we believe that the

Radio Broadcast Photograph

FIG. 19. IN PLACE OF RECORDS

Here is illustrated a method of mounting the Radio Broadcast Phonograph receiver unit in that part of a Victrola cabinet ordinarily used for the storage of phonograph records. Several shelves have been removed to make room for the unit and some shelves for records still remain. A loud speaker unit has been mounted on the tone arm thereby making use of the Victrola sound box mounted within the cabinet

Radio Broadcast Photograph

FIG. 20. THE CUSHION SOCKETS

The photograph illustrates how the Benjamin spring cushion sockets may be mounted directly on the sub-panel. A manufactured unit of this type is being marketed by the Benjamin Company

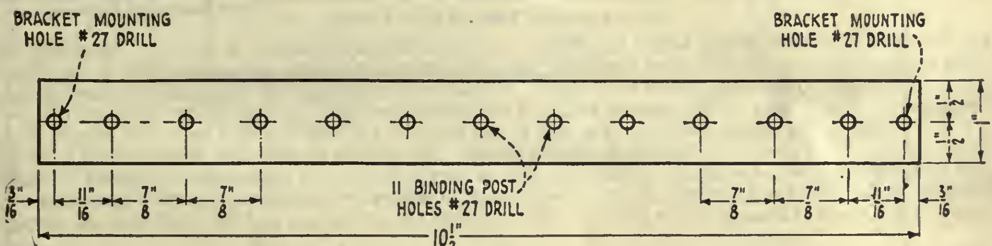


FIG. 21. THE BAKELITE BINDING POST LAYOUT

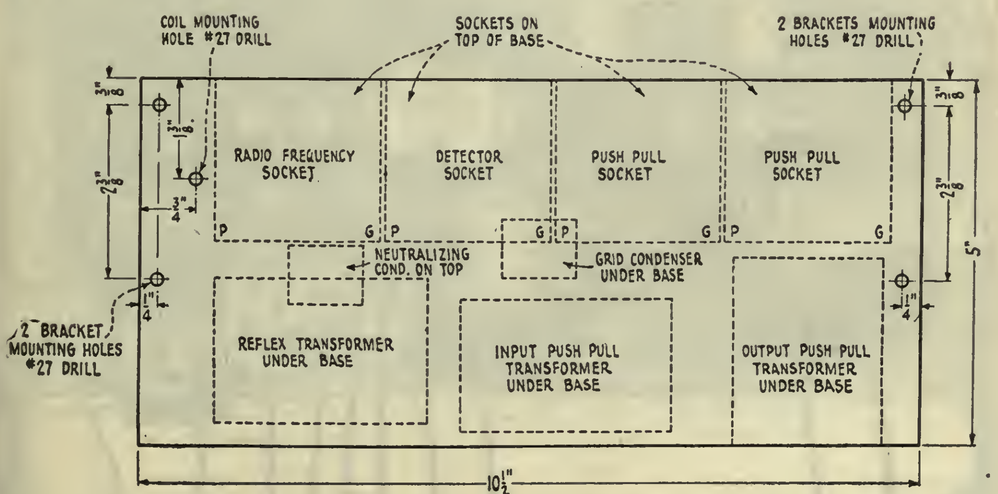
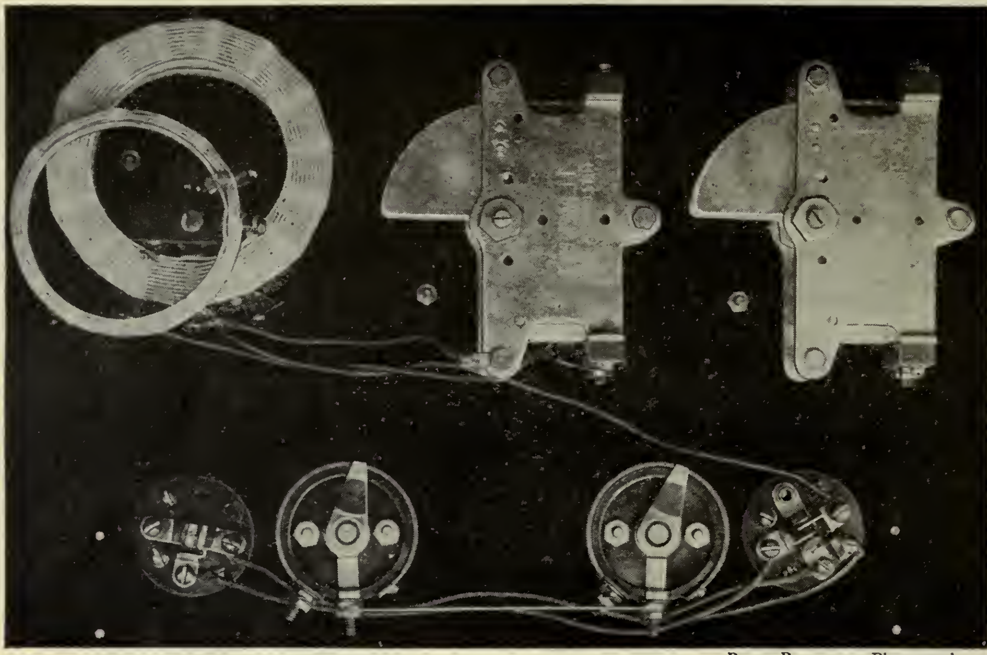


FIG. 22. THE SUB-PANEL LAYOUT

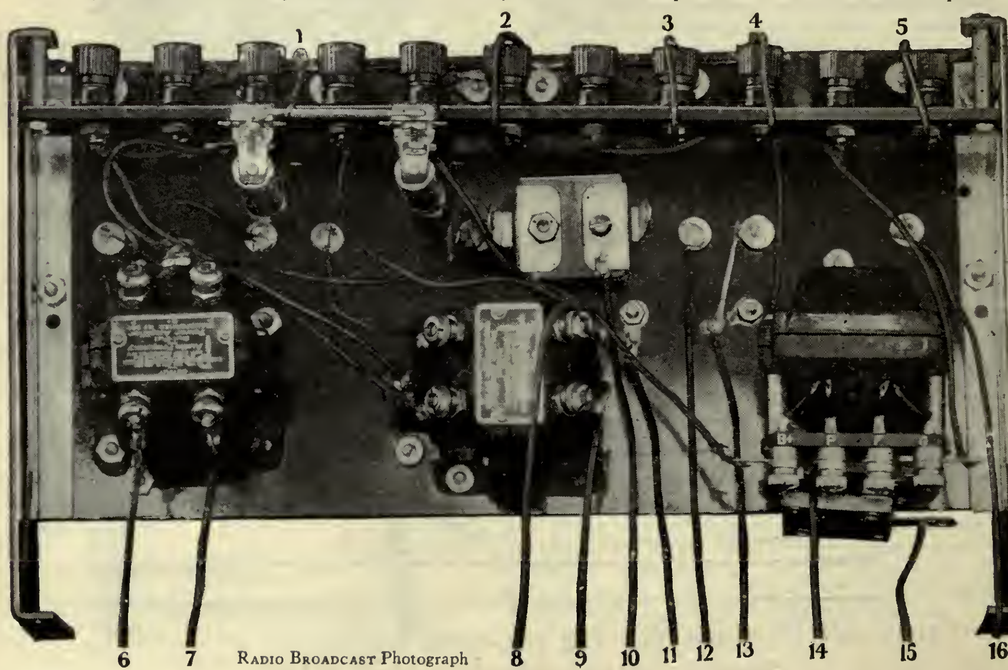
Showing how the parts are placed underneath the base



RADIO BROADCAST Photograph

FIG. 23A—B. THE MAIN PANEL

And sub-base with most of the wiring completed. A circuit diagram is shown in Fig. 8. The numbered leads are connected to the following terminals; they may be traced directly to the apparatus in the Figure above. No. 1 goes to the single circuit inside jack. No. 2 connects to the outside filament circuit and double circuit jack. No. 3 goes to the ground lead and the switch arm. No. 4 leads to the antenna coil T-1. No. 5 connects to the inside secondary T-2 and to the rotary C-1. Nos. 6 and 7 go to the output jack, single circuit. No. 8 goes to the inside jack, double circuit. No. 9 to the outside jack, double circuit. No. 10 goes to stationary plate C-2 inside T-2 secondary. No. 11 goes to the N-P coil neutralizing condenser. No. 12 connects to the tickler coil detector plate. No. 13 goes to stationary plate C-1 and outside secondary T-1. No. 14 is connected directly to the tickler. No. 15, to the center tap N-P and No. 16 to N-P coil plate



RADIO BROADCAST Photograph

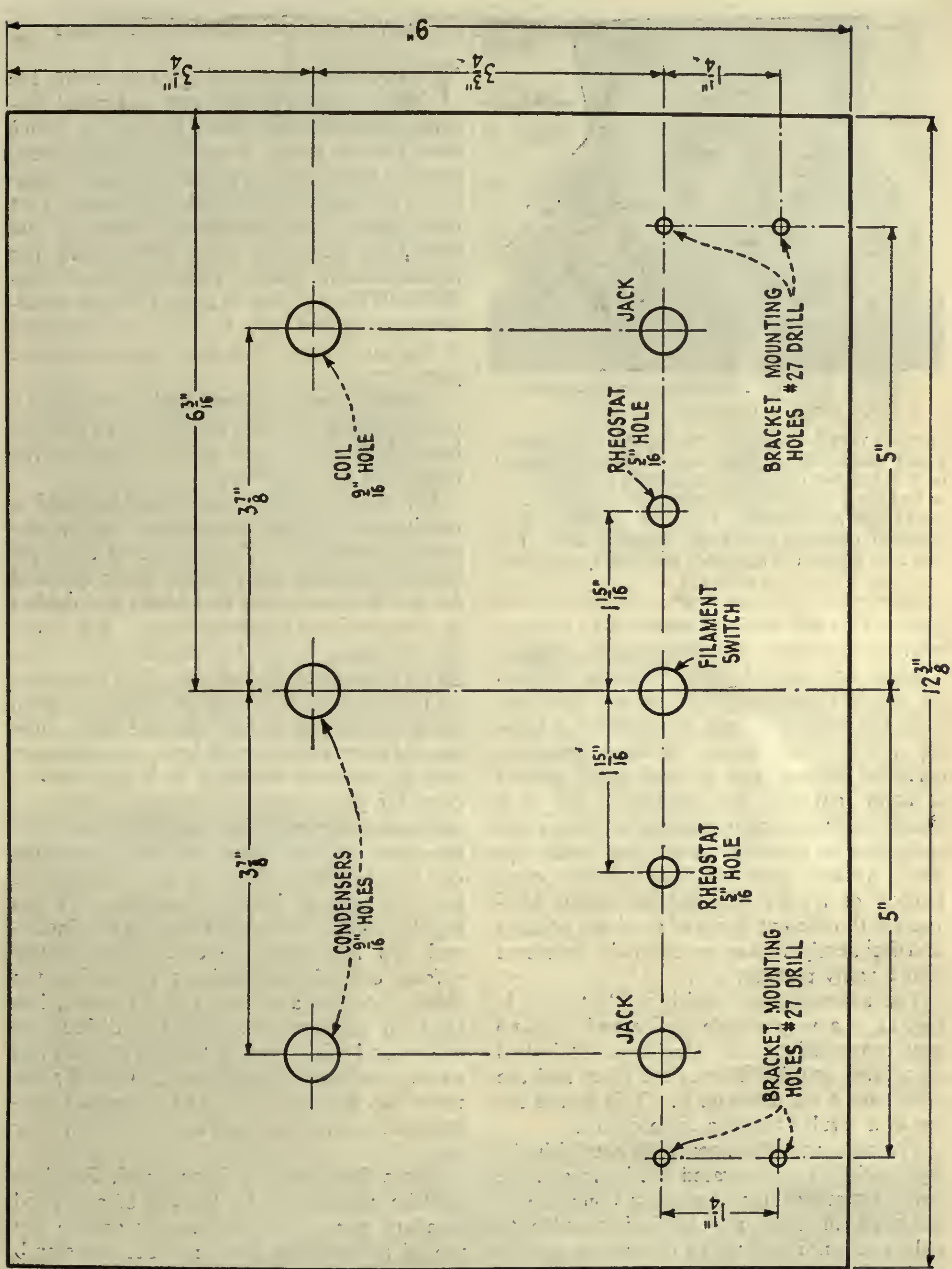


FIG. 24. THE MAIN PANEL LAYOUT

Showing drill sizes and dimensions. No condenser mounting holes are indicated because this depends upon the type of condenser used

Radio Broadcast Photograph

FIG. 25

Shows a very fine addition to any radio and phonograph combination. The use of th ephonograph horn for either radio or phonograph purposes may be had by turning the knob shown in the direct center of the illustration. The loud speaker unit is mounted upon the cap of the Selectron unit. The tone arm fits on the right side and the speaker unit on the left

concern that will manufacture such an antenna will have no trouble in marketing this product.

There are several other antenna devices for use in connection with electric light circuits and telephone lines which make a regular antenna unnecessary. Where there is a portable receiver and a small loud speaker at hand that may be put in the car, it is becoming increasingly popular for the radio enthusiast to take his "music box" with him when visiting friends. This makes comparison of results obtained in various locations with different types of receivers possible and frequently makes an otherwise boresome visit a really pleasant one.

The antennaphone, which is illustrated in Fig. 11, is a very simple device and is in no way connected to the telephone. It is laid on a table or other convenient place and the telephone is set down on it. This makes the use of a regular antenna unnecessary.

The antenna attachments for use with the light sockets are illustrated in Fig. 12 and the various methods for employing them are illustrated in Fig. 13. It is impossible to tell in advance just which connection will be best. Each should be tried. Devices of this kind have been found of little value in some places but better than a regular antenna in others. Radio products of reliable manufacture are sold on a money-back-guarantee basis. They are well worth trying for those whose problem of antenna erection is difficult and often impossible.

ANY STANDARD PARTS MAY BE USED

THERE is little necessity for reviewing the havoc caused by the new and novel features which have attracted the buying public from time to time. Buyers have spent large sums of money in the purchase of new equipment, spuriously advertised, only to find that their money had been grossly misspent and that their purchases were neither new nor revolutionary. Quite probably many individuals have grown to think that the manufacturers desired only to sell parts regardless of the satisfaction that they might otherwise give.

After all, there is but one basis upon which a parts business can exist and that is to give the home builder at least some value for the money he has expended.

For example, there once was heralded a revolutionary super-heterodyne which employed nine tubes. As a result of the publicity it received many of the parts specified for use in it were sold to jobbers and dealers in comparatively large quantities. But it did not last long; it was too unreliable for that. As an example of its "efficiency" it consumed 73 milliamperes in the plate circuit—a good super-heterodyne should not use more than 20, and many require much less—the Hanscom six-tube receiver described in Radio Broadcast for June, 1924, for instance. Now, 73 milliamperes means that dry cells are out of the question and even battery eliminators can not be used. There is then nothing left but storage B battery operation. When equally satisfactory results may be obtained—and this is stating the case conservatively—from one of the receivers employing the Roberts circuit and four tubes drawing less than 10 milliamperes, it is not difficult to understand what we are talking about when we say we are trying to show how good radio parts can be bought by the interested constructor, and real service be secured from their use.

Radio Broadcast's Phonograph Receiver may be constructed by the use of any good standard parts, but we strongly oppose the use of parts which have not become standard.

After all, it is the consumer who eventually pays the piper and we can but hope that he, in making his purchase, will choose only those products which he knows to be sound. Eventually this practice will lead to a market unencumbered by the "gyp" parasites which at times even now defile it.

FIG. I.

FIG. 2

FIG. 3

FIG. 4

A CONNECTION CORD FOR OUTSIDE LEADS

In the Phonograph receiver. Figs. 1 to 4 show the processes in preparing the wires for attaching at both ends. The cable, composed of two No. 16 and three No. 20 conductors is used to connect the batteries to the set. The conductors are each rubber insulated and each of a different color. First shirr the outer braid back about six or eight inches, or as far back as is necessary to make connections. Next fold the loose ends back over the cable and finish off neatly by wrapping a piece of half-inch adhesive tape around the cable as shown in Fig. 2. With scissors, trim off the frayed edges as shown in Fig. 3. In preparing the individual conductors, slice the insulation at three or four points around the wire about one inch back, permitting the insulation to be removed very easily. The finished ends my be wrapped with a quarter-inch strip of adhesive tape for neatness. If some shellac is available, the ends might be dipped in it and dried before the insulation is removed. The copper wire should be scraped brightly and twisted tightly to prevent the wires from spreading. Fig. 5 shows one end of the completed lead. In the Phonograph Receiver, the top lead is plus B 120 volts, the next to the left is plus B 90 volts, the third plus B 45 volts, the next plus A, and the last minus A and B. This does not provide for C battery connections, which should be made with separate leads. The C battery itself can well be included inside the set. Considerable importance attaches to proper C battery potential in this receiver. This cord is available on the market as R–1360 and made by the Belden Manufacturing Company.

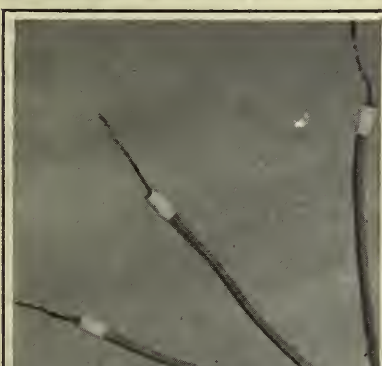


FIG. 5

"NOW, I HAVE FOUND . . . . . ."

A Department Where Readers Can Exchange Ideas and Suggestions of Value to the Radio Constructor and Operator

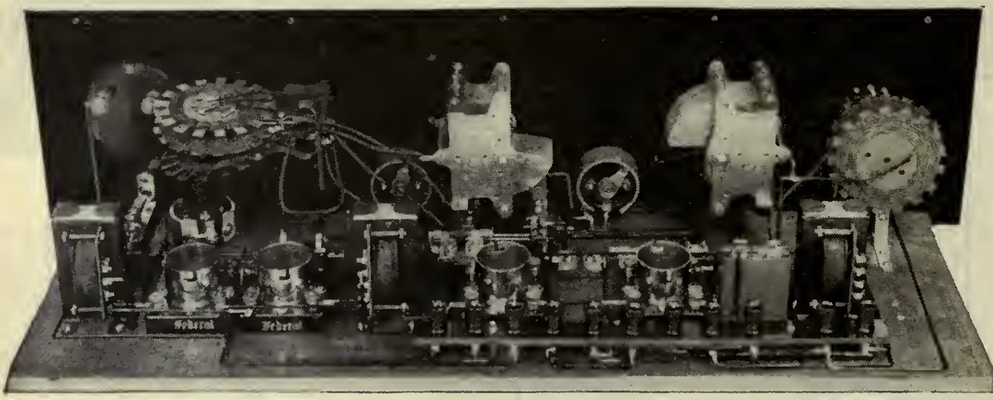


FIG. I

A FOUR TUBE ROBERTS RECEIVER

THE outfit shown in the photograph, Fig. 1. represents one of the highest types of receivers embodying the Roberts circuit. Of several hundred various Roberts sets made by the writer and Mr. S. Schneider, it was selected as the best of the lot as far as tone quality and ease of volume control were concerned.

The feature of the set is its employment of a brace of Western Electric push-pull transformers removed from a 7-A amplifier unit. The tapped input transformer is connected in the circuit as the reflex transformer, feeding the audio component of the detector plate current back into the grid circuit of the first tube. The secondary winding is the tapped one, there being five taps in all. The switch arm is connected to the positive side of the C battery, and the negative pole of the latter is then carried to the lower side of the antenna coupler secondary.

The actual switch and contact points are mounted on the panel at the extreme left. They are not visible in the photograph because they are covered by the antenna coupler coils. This switch directly controls the volume obtainable from the receiver.

The push-pull transformers are wired to a pair of tube sockets in the standard arrangement. These parts occupy the section of the baseboard to the right of the detector tube socket.

Two automatic filament control jacks allow the use of either two or four tubes. Individual rheostats are provided on the panel for the r. f. and detector tubes, while another rheostat, screwed to the baseboard near the second phone jack, regulates the less critical audio bulbs. This third rheostat is turned to the best position for amplifier operation, and can then be entirely neglected. The filament jacks take care of all switching.

The unusual transformer system does not alter the operating characteristics of the circuit in the slightest. The set tunes exactly like other Roberts sets.

In active service this receiver is truly a "knockout." It is being used by a resident of Washington Heights, New York City, and under the adverse local conditions has brought in Pacific Coast stations on only two tubes. The reproduction, thanks to the excellent transformers, is as perfect as the modulation of the broadcasting stations permits. The volume with UV-201A tubes, or others of similar constants, is more than sufficient for the large apartment in which the set is used. And the appearance, it might be stated, is quite commensurate with the electrical efficiency.—H. Q. HORNEIJ, New York City.

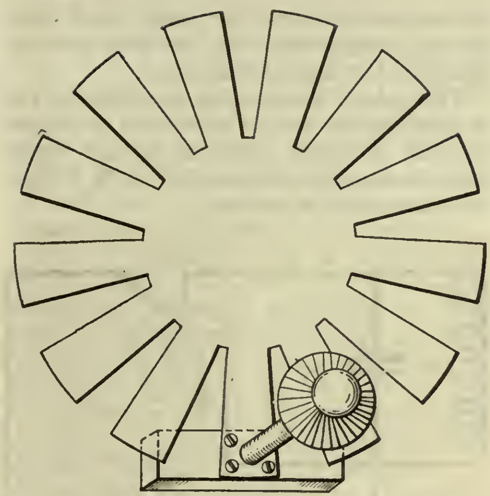


FIG. 2B

A COIL MOUNT FOR THE ROBERTS COILS

A SIMPLE variable mounting for the antenna inductance of the Roberts receiver may be a practical suggestion which will interest the readers of RADIO BROADCAST.

The several Figures are as follows: Fig. 2 A—the assembled coils, cross section view; Fig. 2 B front view of secondary, unassembled; Fig. 2 C—cross section view of antenna coil, unassembled.

The blocks of wood which hold the coils are $\frac{1}{2}$ inch thick. The constructor may use his own judgment as to the width but $1\frac{1}{2}$ by $1\frac{1}{2}$ by $\frac{1}{2}$ inches has been found satisfactory for the secondary mounting and 1 by $1\frac{1}{2}$ by $\frac{1}{2}$ inch for the antenna mounting.

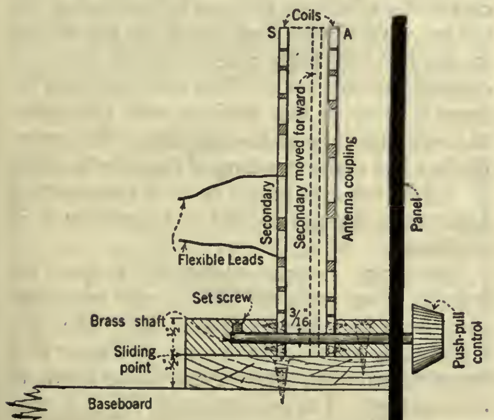


FIG. 2A

The base which supports the sliding secondary and the stationary antenna coil is $\frac{1}{2}$ inch thick, $1\frac{1}{2}$ inches wide and 4 inches long.

This base may be set back a distance from the panel, and the control rod cut to the proper length accordingly.

The antenna coil is fastened to the block by small screws. This block is permanently fastened to the base. It has a hole drilled in it to allow the shaft which moves the secondary to pass back and forth through it.

With this arrangement, very fine variable coupling between the primary and secondary coils may be obtained.

The sketches show very clearly the mechanical features involved in the construction of these mountings.—H. BATCHELDER, Yakima, Washington.

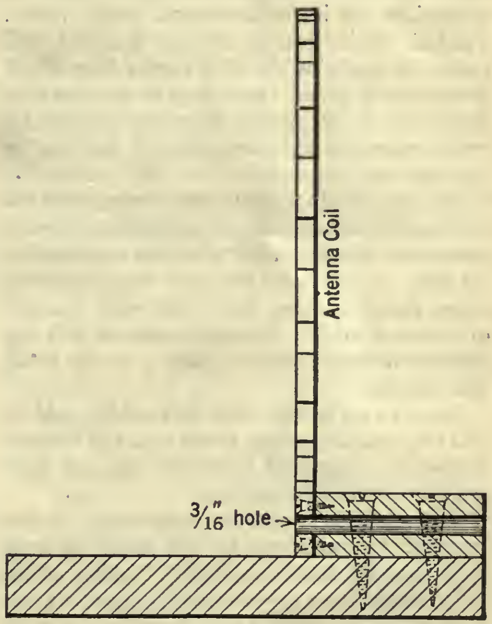


FIG. 2C

HOW TO MAKE A LOW MELTING POINT SOLDER

WHAT radio fan has not found, when soldering, that some of the work got so hot that either the appearance or utility of the soldered part was affected?

While in many cases it may be true that sufficient experience would have allowed the constructor to avoid the trouble, still any method of soldering with less heat would be greatly appreciated by many of us. The answer is simple. Use solder that melts at a

lower temperature than that ordinarily sold on the market.

Solder is made of a mixture of lead and tin. Since tin is much more expensive than lead, the manufacturer is inclined to put in more lead and less tin. Probably no solder available to the radio fan is more than half tin, in spite of the fact that the melting point of solder becomes lower and lower with the increase of tin until a combination of about three fourths tin is reached. Such solder, with a low melting point, is known as "soft solder."

Soft solder may easily be made in the home by adding tin to ordinary solder. Small quantities of tin are available in every home in the form of ordinary tin-foil. One must notice that not all of the "tin-foil" is really made of tin. The genuine article may be recognized by its softness and bright finish. Tin-foil which comes around eatables will really be made of tin if it comes into direct contact with them. One may be certain that foil which is separated from the eatable by waxed paper is not pure tin and can not be used for this purpose.

To get the tin into usable shape, put the foil into a metal cover, such as a baking powder can cover, and add to it about as much rosin, by bulk, as you have foil, and then heat over a gas stove or other fire. Stir with the end of a match stick. Presently the tin will appear as a bright puddle with a lot of black dirt over it.

Now, to make the extra soft solder, add to this tin, ordinary solder about equal in amount to the tin recovered from the foil and heat until the two melt together.

The resulting compound may be left in the cover to be picked up by the soldering iron, or it may be made into "wire" solder either by pouring into a groove gouged out of a piece of wood or by pouring into a soda straw with the lower end pinched shut.

By using a soldering iron just hot enough to cause the solder to flow freely when using this soft solder, work may be done with appreciably less heating than usual.

This solder is not quite as strong as the ordinary solder, but, in radio work, joints are soldered for good electrical contact rather than for mechanical strength.—G. D. ROBINSON, Annapolis, Maryland.

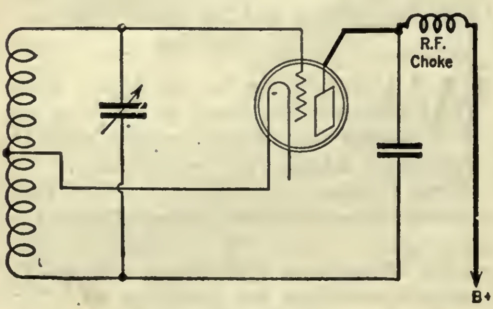


FIG. 4

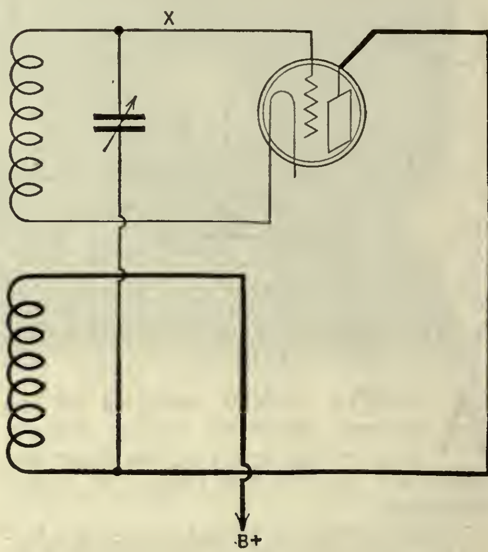


FIG. 3

THE OSCILLATOR IN YOUR SUPER-HETERODYNE

IT IS not the purpose of this article to extol the super-heterodyne but to show you how to make yours more efficient. By efficiency I mean output divided by input. It is obvious that with a given input we can increase the efficiency of a set by increasing the output. Or if with a smaller input the output is the same in both cases then we have increased the efficiency. The average radio listener is more or less familiar with the action of a vacuum tube as an amplifier. He probably has less understanding of the tube's action as a detector and unless he is a transmitting amateur he has practically no knowledge of an oscillator.

There are several oscillating systems in popular favor with the amateur for transmitting purposes, but of these only one, the Hartley, is satisfactory as an oscillator in a super-heterodyne. There are three forms of the Hartley. The one shown in, Fig. 3 is used almost universally, and this is the one we are about to consider.

As a generator of alternating current this form of oscillator is above reproach. In fact it does that too well, for it generates a lot more current than we can possibly use, and in the matter of squeals it is almost as great an offender as those receivers we know as bloopers. This is perhaps the most serious charge that can be brought against it. Used in its present form it is not as efficient as it might be.

Such an oscillator, with 5 volts filament supply and 90 volts plate supply, will draw about .025 amperes (25 milliamperes.) If we stop the tube from oscillating by short circuiting the grid coil, the plate current drops to 6 or 7 milliamperes.

If we cut the plate voltage down to 20 volts, the tube, oscillating, will draw about 5 milliamperes. But this is not good enough.

There is no advantage in using a 201A tube as an oscillator. A UV–199 is suitable for all of our purposes. By using a UV-199 in the circuit in Fig. 3, with 20 volts on the plate, the B battery drain will be but 3 milliamperes. This is better since we have also reduced our A battery current. A UV–199 can be used in the same set with UV–201A tubes by using a separate rheostat, or better an amperite.

Fig. 4 is a form of Hartley oscillator in common use among amateurs for transmftting purposes but there is nothing in particular to be gained by its use.

A third form of Hartley oscillator is shown in Fig. 5. This is the ideal form for our purposes. The plate current for a UV–199 oscillator with the constants shown, will be from .0001 to .00015 amperes (100 to 150 microamperes). If you are using 45 volts on the detector plate and do not want to provide a separate B battery connection for the oscillator, you will have to use a somewhat lower resistance grid leak. This oscillator will give you all the output that you can use to advantage. However, it is not strong enough to radiate seriously and it will oscillate smoothly and evenly over the entire broadcasting wavelength range.

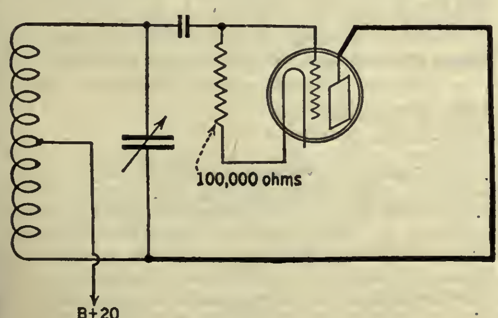


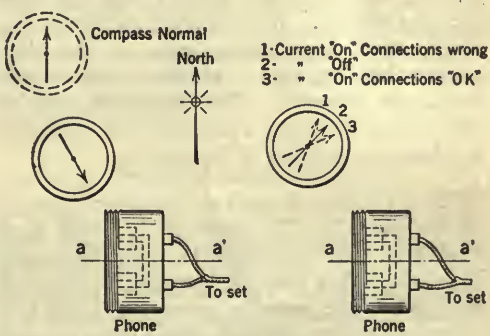
FIG. 5

A tube will often oscillate in this circuit when it will not in the first one shown here, because the filament emission is not great enough to sustain oscillations in the former.

If the tube is stopped from oscillating in the circuit shown in Fig. 5 the plate current rises to about .4 milliamperes. If the filament emission is great enough to supply a plate current of 0.2 milliamperes, it will oscillate in this circuit.

The insertion of a grid leak and condenser at the point marked X in Fig. 3 will result in a greatly improved oscillator—almost as good as that shown in Fig. 5. However, for those who already have a "super," it offers less changing in wiring and will do very nicely.

There are several schemes for using the so-called first detector as an oscillator. Examples of this are the second harmonic oscillating system and the Pressley method. I do not recommend any of these because the added impedence in the grid circuit of this first tube more than offsets any advantage gained by using this tube—especially when a really good oscillator consumes only 60 milliamperes of A battery, and 15 microamperes of B battery, current.—F. W. HUTTON, Woodhaven, New York.



FIGS. 6 AND 7

A PHONE CIRCUIT TEST

IT IS quite commonly known that to insure long life to the permanent magnets of phones, the field produced by the plate current flowing through the phone windings should assist and not buck that set up by the permanent magnets. Relatively few experimenters know how to determine which condition exists.

The object of this article is to give an experimental method for such determination involving no more elaborate apparatus than

a pocket-compass, which should, however, be fairly sensitive. No knowledge of electricity is needed, although of course it would help the operator understand the "why" of the method.

First unscrew the cap from the receiver and remove the diaphragm (unless the receiver be of the Baldwin type which has a mica diaphragm). The phones and compass should then be placed in the relative positions shown in Fig. 6, paying attention to the fact that the compass should be north of the receiver. The north-seeking pole should point toward the phone when brought near it. If such is not the case, the receiver should be revolved about the axis $a-a_1$, bringing the other pole nearest the compass.

The compass, which may be placed on a safety match box or anything not having iron or steel in its construction to facilitate movement, is then shifted to a position approximately as shown in Fig. 7. The exact spot is determined by finding where the needle starts to swing to its normal north-seeking position. Just before it has left the influence of the phone magnet, which is when further slight movement causes the needle to swing abruptly toward the north, the plate current should be allowed to flow through the phones, preferably when a strong signal is coming through. If the needle swings toward the phones, the fields are mutual and the connections correct. If the needle swings to the north, the phone connections to the plug or the binding posts, whichever are used, should be reversed. The deflection will be slight but unmistakable.—L. T. PHELAN, Washington, District of Columbia.

TO-DAY, there is small necessity for "matching tubes". The fact is, for most purposes tubes are so similar in their characteristics that they may be considered as being matched. The notable exception is in the super-heterodyne, where juggling tubes around in the intermediate stages is usually necessary to secure satisfactory reception. Howling, instability (uncontrollable oscillations with beat whistles) at normal plate voltages are evidence of poor or improperly balanced tubes in the intermediate amplifier.

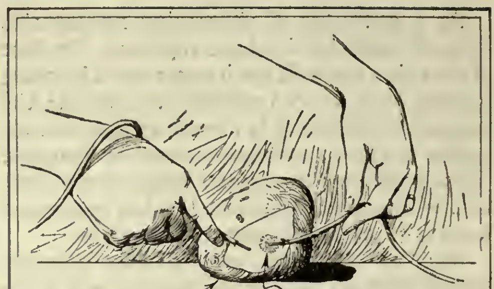


FIG. 8

DETERMINING THE POLARITY OF A BATTERY WITH A POTATO

THERE are devices on the market for finding the polarity of an electric battery. That is, to find out which is the negative pole and which is the positive pole. This is always necessary when connecting up an automobile or a radio battery or in making electrical experiments. But did you know that all this could be done with the aid of a common white potato?

Choose a potato with nice white meat and shave off a section of skin about the size of a half dollar so that the inside is exposed. Then turn on the current from your source of electricity and grasp one of the wires with bared ends in each hand. Touch the wire ends to the potato about $\frac{1}{8}$ inch apart and watch the result. In a few seconds the potato under one of the wires will be found to turn a shade of green. The section of the potato which the other wire touches will remain clear and white. See Fig. 8.

The wire causing the greenish hue on the potato is connected to the *positive* pole of the battery. Therefore the other wire must be connected to the negative pole. This experiment will not work on alternating current of the house lighting circuit. It is a good test, however for storage or dry batteries or small, direct current generators such as are found in cars and power boats.—L. B. ROBBINS, Harwich, Massachusetts.

THE "Now I Have Found . . ." department in this magazine is planned to furnish an outlet for the many excellent ideas dealing with various features of radio construction and operation which reach our office. If you have an idea about a valuable and useful new circuit, some new device, or a construction or operating suggestion, we should like to have it. We do not want simple or obvious suggestions, and material to be acceptable for this department must offer something of definite value to the constructor; mere novelty is not desired. Payment from two to ten dollars will be made for every idea accepted. Manuscript should not be longer than 300 words and typewritten. An award of twenty-five dollars will be paid for the best article published in every three-month's period. Address your manuscript to this department, RADIO BROADCAST, Garden City, New York

See the Announcement on Page 418

QUERIES ANSWERED

Can a loop be used with one-tube sets?
P. B.—Canton, N. Y.

Will you explain the meaning of wavelength?
F. C.—Lansing, Mich.

How does the high-mu receiver differ from the Roberts?
E. L. J.—Berkeley, Calif.

How shall I be guided in the selection of a storage battery?
A. M.—Brooklyn, N. Y.

Is the four-tube crystal reflex circuit in the June, 1924, issue of Radio Broadcast correct?
J. N. T.—San Antonio, Texas.

Will you publish a circuit showing a neutrodyne receiver employing push-pull audio frequency amplification for the last stage?
L. J. T. Portland, Me.

What tools are necessary for good radio construction?
K. W. J.—Marion, Ohio.

How may I procure the Lynch lead described in the June, 1925, Radio Broadcast
R. B.—Albany, N. Y.

LOOPS

THE energy transmitted by a broadcasting station must be collected or absorbed by some collective or absorbing agency so that a receiver may be actuated to produce results. Upon the size of this agency depends the efficiency at which the receiver operates, all other things being equal. However, this agency, which is the antenna, also is affected by other electrical disturbances in the ether, i. e., atmospherics, artificial static like motor commutator sparking, sparking trolley lines, defective power lines, and similar disturbances.

On one-, two-, and three-tube sets, an outside antenna is connected to the detector tube through a coupler unit. A loop will not be satisfactory for such a receiver because the feeble impulses which it receives will not actuate the detector tube sufficiently to produce energy which may be transformed into an audible signal.

A loop can only be used on receivers employing one or more stages of radio frequency amplification or in super-heterodynes which tend to magnify these feebly received impulses so that they are strong enough to be heard after being rectified to an audible signal in the detector tube.

While an antenna has directional effects, it is not practicable to move it about so that signals from all directions may be received with comparatively equal strength.

A loop can be rotated without much effort, for directional effects. The larger, physically, a loop is the greater its energy pickup will be. However, for most practical purposes its size is limited by individual requirements.
then we have the equation

WHAT WAVELENGTH MEANS

RADIO waves travel through space at the same velocity as light, roughly 186,000 miles per second. Rather, the wave motion is propagated at that velocity, which, when spoken of in meters equals 300,000,000 meters per second. That is a fixed value. Now if we vary the length of one wave, the frequency or number of times it will repeat itself, will vary. As represented in a formula

$$\text{Frequency} = \frac{186{,}000 \text{ miles } (300{,}000{,}000 \text{ meters})}{\text{length of wave}}$$

If N equals the frequency or number of oscillations occurring, V (300,000,000) indicates velocity of waves in meters, and L equals length of wave form then we have the equation.

$$\nu = \frac{V}{L}$$

L, the length of one wave depends upon the adjustments of the tuning elements to produce an oscillation which repeats itself in a propagated wave

form at a certain frequency. We can term this the number of oscillations produced by an adjustment which gives each oscillation a definite length in meters.

Reduced the formula is

$$N = \frac{V}{\lambda}$$

To deal with round numbers let us suppose we start with a wave 1 meter long. Then the number of oscillations (waves or cycles) occurring during the one second it takes to travel 186,000 miles (or 300,000,000 meters) is exactly 300,000,000.

Supposing we wish to determine the frequency (N) of a wave 600 meters in length then

$$N = \frac{300,000,000}{600} = 500,000 \text{ oscillations}$$

If it is a wave 300 meters long then

$$N = \frac{300,000,000}{300} = 1,000,000 \text{ oscillations}$$

If it is a wave 150 meters long then

$$N = \frac{300,000,000}{150} = 2,000,000 \text{ oscillations}$$

Therefore from this we can judge that while the speed at which the wave travels remains constant, any change in wavelength will alter the number of oscillations (waves) occurring over that distance of 186,000 miles. This is explained in Fig. 1 A, B, and C.

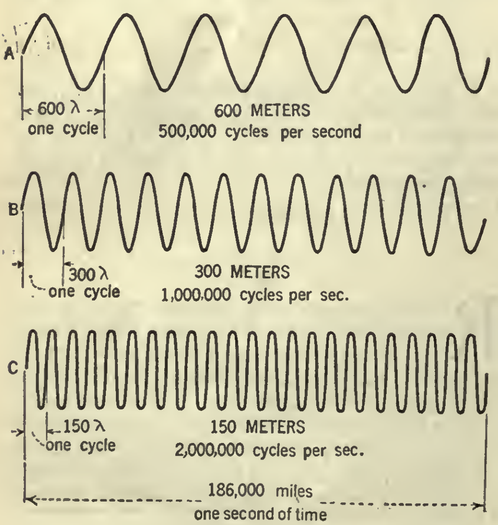


FIG. 1

Since the space covered by the wave forms is 186,000 miles then for each one there occurs a different number of waves in that space.

Assuming that the same power is used in all three cases to produce the same amplitude then in A (600 meters) there will be 500,000 oscillations or cycles each 600 meters long from start to finish. In B there will be 1,000,000 and in C there will be 2,000,000,

Summing up we can say that the length of one cycle determines the number of cycles occurring during one second of time or covering 186,000 miles.

In broadcasting, a station transmits a wave called the carrier wave, which has a constant amplitude. This wave, occurring at a frequency to which the transmitter has been adjusted, is inaudible to the ear. Now by super-imposing an audio frequency wave on it, it is modulated into varying amplitudes but still inaudible until rectified by the detector tube.

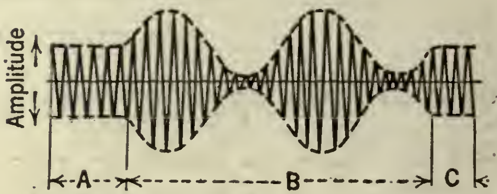


FIG. 2

Fig. 2 shows how the modulated wave, to conform to the voice and music variations, is produced. At A we have the constant amplitude of the carrier wave but between A and C (B) the wave is of a continually varying amplitude. This is due to the audio wave being super-imposed on the carrier wave.

THE HIGH MU AND THE ROBERTS

THE question arises "how does the High-Mu Browning-Drake receiver differ from the Roberts Knockout?" Well fundamentally both circuits are similar, each employing a stage of radio frequency amplification before a regenerative detector circuit. However, in the Roberts Knockout, the first tube circuit contains a reflex audio transformer providing an additional stage of audio amplification. Also, the neutralization methods are not alike. The novel Roberts system is quite different in principle to that employed in the High-Mu receiver which is similar to the standard Hazeltine neutralizing scheme.

The High-Mu receiver was designed for use with UV-199 tubes but UV-201A's may be employed without any changes other than supplying the correct filament and plate voltages. This is borne out in the description of the "Good Four Tube Receiver" in this magazine for March, 1925, which is very similar to both the Roberts and High-Mu sets.

HOW TO SELECT A STORAGE BATTERY

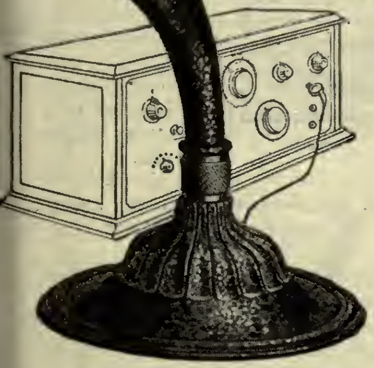
WHEN selecting a storage battery, every owner of a receiving set desires one of sufficient capacity to make frequent recharging unnecessary, yet small enough to reduce the first cost to a minimum. The owner's ideas about what

Music Master Resonant Wood Insures Natural Tone Quality

Connect Music Master in place of headphones. No batteries. No adjustments.

Prices of all models slightly higher in Canada.

Music Master Makes any good set BETTER



Model VI, 14" Wood Bell $30

Model VII. 21" Wood Bell $35

Music Master transforms mere radio reproduction into artistic re-creation. Mere assertion? No! Plain fact—because:

THE piano's sound board, the violin and 'cello, and Music Master's amplifying bell are all of wood—because wood produces *natural* tones.

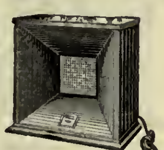
Heavy cast aluminum eliminates over-vibration, develops sound without distortion and imparts a *unique* tonal brilliance.

This balance of resonant wood and non-resonant metal preserves, reproduces and re-creates the natural qualities of instrument and voice—and makes

Music Master the Supreme *Musical Instrument of Radio,* for which there IS no substitute.

Buy Music Master and be safe—buy Music Master and improve your set—buy Music Master and exchange mere radio receiving for the artistic enjoyment of radio re-creation.

Model VIII, Mahogany Cabinet with *full-floating* Wood Bell $35



Model V, Metal Cabinet, Mahogany Finish, Wood Bell $18

Music Master Corporation

Makers and Distributors of High-Grade Radio Apparatus

Tenth and Cherry Streets

Chicago PHILADELPHIA *Pittsburgh*

Canadian Factory: Kitchener, Ontario

Music Master
RADIO *REPRODUCER*

to specify, in order to obtain this highly desirable combination may be somewhat hazy, but he is never in doubt as to the result he seeks.

Various types of storage battery selection charts have been developed in the past, which were intended to assist the owner of a receiving set in making a proper selection. Generally speaking, these charts recommended certain types and capacities of batteries for certain tubes. The Prest-O-Lite Storage Battery Laboratories have just developed a chart which takes into consideration the numbers, types, and combinations of tubes in a way that makes the selection of a satisfactory battery a simple matter.

Voltage of tubes, number of tubes, type of tubes, the rated ampere drain and the recharging interval are treated in the chart in such a way that the receiving set owner has a choice of two recharging periods. For instance, for a set using one UV-200 and three UV-201A tubes, with a rated ampere drain of $1\frac{3}{4}$, and an A battery of 115 amperes (at a one ampere drain) will give 22 days of service without recharging when used daily for an average of three hours; while with the same tube combination, a battery of 80 amperes will have a recharging interval of 15 days. Similarly, for a set having three UV-201A tubes at a $\frac{3}{4}$-ampere drain, a battery of 65 amperes insures 29 days of service while the smaller 47-ampere battery gives 22 days of service between rechargings.

By recalling attention to the types of tubes that are interchangeable, it will be noted that the accompanying chart, Fig. 3, gives practically every combination of 5-volt tubes in general use.

Voltage of Tubes	No. of Tubes in Set	Type of Tubes (see foot-note)	Total Rated Ampere Drain	Storage "A" Battery Size Recommended: Amp. Hours at 1 Amp. Drain	Storage "A" Battery Size Recommended: Days between Chargings
5-Volt Tubes	1	UV-200	1	65	22
				or 47	16
C-300 and UV-200 are interchangeable	2	UV-201A	½	47	33
	2	1 UV-200 1 UV-201A	1¼	80	22
C-301A, DV-2 and UV-201A are interchangeable				or 65	17
	3	UV-201A	¾	65	29
				or 47	22
	3	1 UV-200 2 UV-201A	1½	95	21
				or 65	14
	4	UV-201A	1	65	22
				or 47	16
	4	1 UV-200 3 UV-201A	1¾	115	22
				or 80	15
	5	UV-201A	1¼	80	22
				or 65	17
	5	1 UV-200 4 UV-201A	2	115	19
				or 80	13
	6	UV-201A	1½	95	21
				or 65	14
	8	UV-201A	2	125	21
				or 95	15
	For sets using current at a rate higher than 2 amperes.		2¼	140	22
				or 95	13
			2½	140	19
Copyright, 1925 The Prest-O-Lite Co., Inc				or 125	16

For combinations of tubes not listed: Use the same battery combinations recommended for tubes having voltage and current requirements similar to the tubes you have.

NOTE: If you use a loud speaker operated from your "A" Battery, add ½ ampere to the total rated current drain of your tubes and then select a battery giving this total current consumption.

FIG. 3

CORRECTIONS IN THE FOUR-TUBE CRYSTAL REFLEX RECEIVER

IN QUESTIONING the accuracy of the four-tube Knockout crystal reflex circuit appearing in Fig. 3 page 103 of the June, 1924, issue of RADIO BROADCAST and also in Fig. 3 page 41 of our Knockout Series Booklet, it has been brought to our

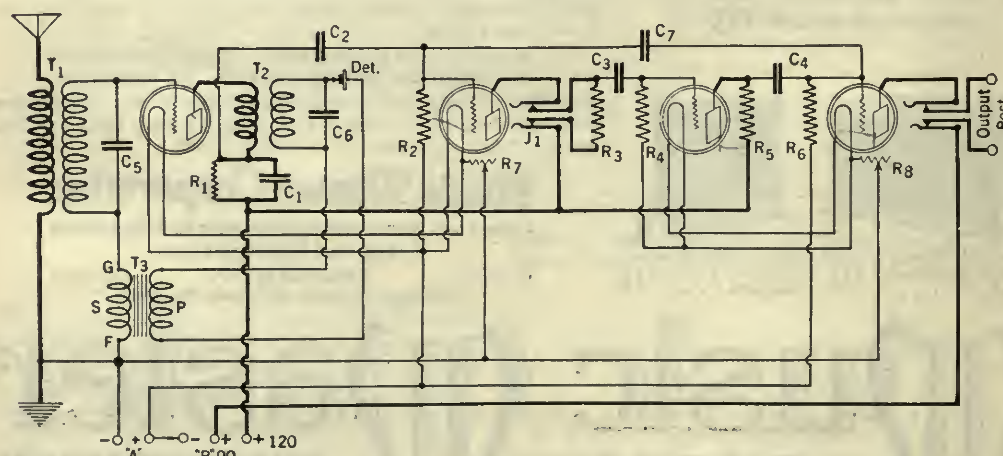
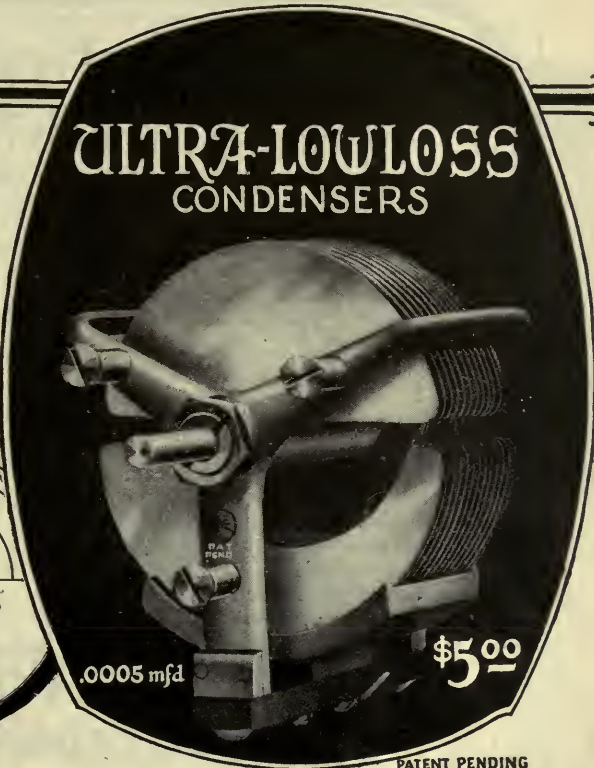
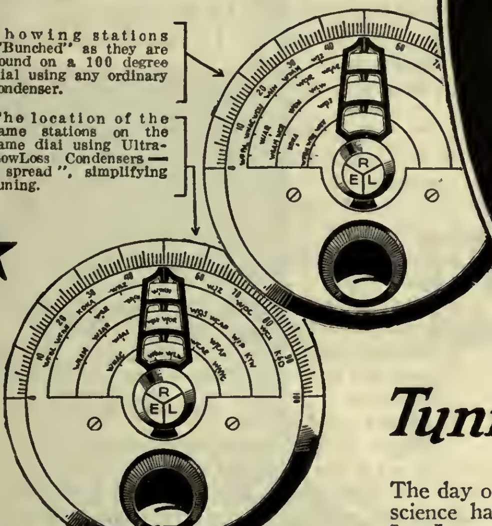


FIG. 4



PATENT PENDING

Stations Don't "Bunch" On the Dials



Showing stations "Bunched" as they are found on a 100 degree dial using any ordinary condenser.

The location of the same stations on the same dial using Ultra-LowLoss Condensers — "spread", simplifying tuning.

Tuning Simplified Now!

The day of tedious fumbling about for your stations is past—science has been brought into play. Now, with the Ultra-LowLoss Condenser you can instantly tune in on any station as easy as turning the hands of a clock to the hour.

With one station of known wavelength located on the dial, all others can be found instantly. Each degree on a 100 degree dial represents approximately 3½ meters difference in wave length. This applies to both high and low wavelengths. Other than 100 degree dials vary accordingly.

This simplification of tuning is made possible by the new Cutless Stator Plates to be found only in the Ultra-LowLoss Condensers. Every feature of the Ultra-LowLoss Condenser was developed with one predominating purpose—to overcome losses common in other condensers. Designed by R. E. Lacault, originator of the famous Ultradyne Receivers and Ultra-Vernier Tuning Controls.

At your dealers, otherwise send purchase price and you will be supplied postpaid.

Design of lowloss coils furnished with each condenser for amateur and broadcast wavelengths showing which will function most efficiently with the condenser.

TO MANUFACTURERS WHO WISH TO IMPROVE THEIR SETS

Mr. Lacault will gladly consult with any manufacturer regarding the application of this condenser to his circuit for obtaining best possible efficiency.

ULTRA-VERNIER TUNING CONTROL

Simplifies radio tuning. Pencil record a station on the dial—thereafter, simply turn the finder to your pencil mark and you get that station instantly. Easy — quick to mount. Eliminates fumbling, guessing. A single vernier control, gear ratio 20 to 1. Furnished clockwise or anti-clockwise in gold or silver finish.

Silver $2.50
Gold $3.50

This seal on a radio product is your assurance of satisfaction and a guarantee of Lacault design.

ULTRA-LOWLOSS CONDENSER

PHENIX RADIO CORPORATION 116-C East 25th Street, New York City

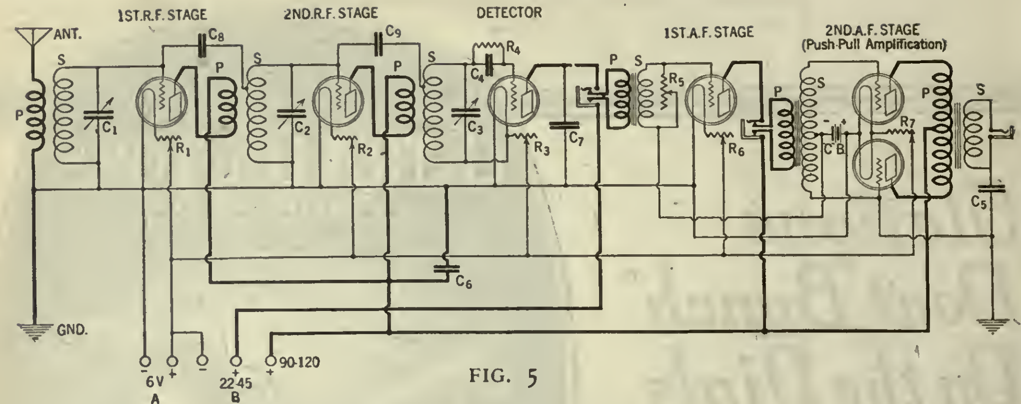


FIG. 5

attention that in its present form the A battery would short-circuit itself through the rheostat R7 when that rheostat is turned on. The defect in the circuit diagram is in making the connection of the lower side of R2 to that lead of the filament circuit connecting to the upper end of the rheostat R7.

The correct connection should be made to the line just below where the connection is now made, or in other words, to that lead running from the left hand side of each of the filaments of the first two tubes.

The corrected circuit diagram appears in Fig. 4.

A NEUTRODYNE CIRCUIT

MR. D. C. asks for a neutrodyne circuit employing a push-pull amplifier as the second audio stage. The complete circuit is shown in Fig. 5.

The values of the various parts are:—

R1, R2, R3, R6, and R7—20-ohm Rheostats
R4—3-megohm grid leak.
R5—Variable resistance 25,000 to 100,000 ohms.
Cb—C Battery $4\frac{1}{2}$ to 9 volts.
C1, C2, C3—Variable condensers—.00035 mfds.
C4—Grid condenser—.00025 mfds.
C5—Stabilizing condenser—.0005 mfds.
C6, C7—Bypass condensers—.006 mfds.
C8, C9—Neutralizing condensers.

The several radio frequency coil units consist of primary and secondary coils wound on $3\frac{1}{2}$ inch bakelite or cardboard tubing. The secondaries are wound with 60 turns of No. 22 DCC wire and the primaries, situated at the lower end of the coil, that is, the end which connects to the negative side of the filament, consist of about 6 to 10 turns of the same wire.

Any standard neutralizing condenser may be employed.

Information relative to the proper neutralization and to the operation of push-pull amplifiers has appeared in past issues of RADIO BROADCAST.

RADIO TOOLS

THE need for good tools in radio construction is paramount where one wants good work to result. The ordinary tools usually to be found around the house are not of very much use. The well-planned radio kit should contain:

2 screw drivers one with $\frac{1}{4}$ inch and another with $\frac{5}{16}$ inch blade.
1 pair of wire cutting pliers.
1 " " side "
1 " " duck bill "
1 " " round nose "
1 centerpunch
1 ball peen hammer
1 scriber
1 adjustable square
1 6-inch scale
1 pair dividers
1 set of socket wrenches
1 soldering iron
1 hand drill and set of drills
Countersink
Brace and wood bits

The scale, square, scriber, centerpunch, hammer, etc., all aid in the laying out and marking of panels, brass and other work, while the hand drill, drills, countersink, etc., are used to do the actual work in the drilling of these materials. Round nose pliers are indispensable for bus wire bending and duckbill pliers may be handy for loosening and tightening nuts, bolts, etc. Side cutting pliers are usually employed for cutting wire and stripping off insulation.

In the use of drills special care should be used when large holes are drilled. It is much easier to drill a $\frac{1}{2}$-inch hole by first using a No. 28 drill in a hand drill and then enlarging it by redrilling with a $\frac{1}{2}$-inch drill inserted in the chuck of a brace, than to drill with a $\frac{1}{2}$-inch drill at the very beginning. Furthermore, this practice tends toward accurate drilling because the point of a larger drill becomes displaced from the centermark easier than a small drill.

A set of socket wrenches or ordinary S wrenches helps the constructor greatly in insuring secure assembly work. It is well to remember that not too much strain should be placed upon nuts and bolts because, due to their soft brass composition, it is easy to strip the threads.

Every constructor ought to have an ample supply of bus wire, lugs, nuts, bolts, washers, and wood screws.

Get a good set—and Evereadys

To ENJOY radio for the rest of your life, get the best set you can afford. There are receivers at all prices, made by reputable manufacturers; it isn't necessary for anyone to get 'round-the-corner, unproved, unreliable merchandise at any price. That applies to batteries too. Eveready Radio Batteries are made in so many sizes and prices that there is a correct, long-lasting Eveready for every receiver and for every radio home, ship or commercial station. Specify Evereadys for your new radio set. It is false economy to buy nondescript batteries at any time. In the long run you'll find it most economical to buy either the large or extra large Evereadys. Always buy Evereadys and enjoy the knowledge that no one can get any more in batteries for the money than you. There is an Eveready dealer nearby.

Manufactured and guaranteed by

NATIONAL CARBON CO., INC.
New York San Francisco
Canadian National Carbon Co., Limited, Toronto, Ontario

EVEREADY
Radio Batteries
—they last longer

EVEREADY HOUR
EVERY TUESDAY
AT 8 P. M.
(Eastern Standard Time)
For real radio enjoyment tune in the "Eveready Group." Broadcast through stations

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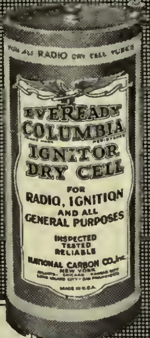
WCAE	Pittsburgh
WEAR	Cleveland
WSAI	Cincinnati
WWJ	Detroit
WCCO	Minneapolis / St. Paul
WOC	Davenport



Eveready Columbia Ignitor the proven Dry Cell for all Radio Dry Cell Tubes 1½ volts

No. 772
45-volt
Large
Vertical
Price
$3.75

No. 766
22½-volt
Large
Horizontal
Price
$2.00

No. 771
4½-volt
"C"
Battery improves quality, saves "B" Batteries
Price
60c

The following is a suggested list of what the supply should be:

	SIZE	LENGTH
Bolts — Round and Flat Head (Brass)	No. $\frac{6}{32}$ No. $\frac{8}{32}$	$\frac{1}{2}'' - \frac{3}{4}'' - 1''$ $\frac{1}{2}'' - \frac{3}{4}'' - 1''$
Nuts — (Hexagon Brass)	No. $\frac{6}{32}$ & $\frac{8}{32}$	
Wood Screws—Round—Flat & Oval Head (Brass or Nickel Plated)	No. 3 No. 5	$\frac{3}{8}''$-$\frac{1}{2}''$-$\frac{3}{4}''$ $\frac{1}{2}''$-$\frac{3}{4}''$-$1''$-$1\frac{1}{2}''$
Washers	—size to fit screws	

LONG CORDS

INQUIRIES have been received asking where the Lynch Lead may be procured. This lead, described in the June 1925 issue of RADIO BROADCAST and illustrated in the frontispiece of this issue of RADIO BROADCAST, making possible the use of an automobile storage battery by plugging in to the lamp socket on the dashboard of a car is manufactured by the Belden Manufacturing Company, Chicago, Illinois, and the Crescent Braid Company, Providence, Rhode Island.

The extra length loudspeaker cord also illustrated in the frontispiece of this issue may be obtained from the Alden Manufacturing Company, Springfield, Massachusetts.

Before You Write to the Grid

THOUSANDS of you are writing the Grid for technical advice every month. The expense of framing a complete and exhaustive reply to each letter is very high. The editors have decided that the benefit of the questions and answers service will continue to be extended to regular subscribers, but that non-subscribers, from April 15, on, will be charged a fee of $1 for each letter of inquiry which they send to our technical department. Very frequently, our technical information service proves of definite money value to you who write us, for we are often able by a sentence or two of explanation, to put you on the right path before you have made a perhaps expensive mistake.

The occasional reader of RADIO BROADCAST will be charged a fee of $1 for complete reply to his questions, and the regular subscriber can continue to take advantage of the service as before. In that way the non-subscriber will help share the cost of the technical staff whose service he gets. Every letter receives the benefit of the experience of the editor and the technical staff and every correspondent may be sure that his questions will receive careful consideration and reply.

When writing to the Grid, please use the blank printed below.

GRID INQUIRY BLANK

Editor, The Grid,
RADIO BROADCAST,
Garden City, New York.

Dear Sir:

Attached please find a sheet containing questions upon which kindly give me fullest possible information. I enclose a stamped return envelope.

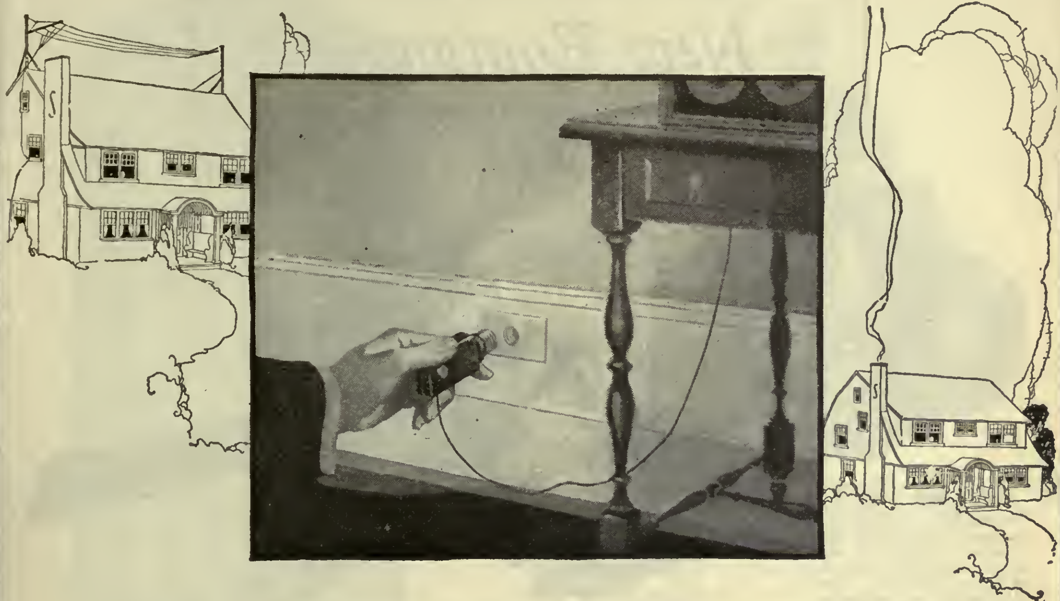
(Check the proper square)

☐ *I am a subscriber to* RADIO BROADCAST. *Information is to be supplied to me free of charge.*

☐ *I am not a subscriber. I enclose $1 to cover costs of a letter answering my questions.*

My name is ______________________________

My address is ______________________________



The $1.50 Ducon and no antenna!

A small Ducon screwed into a light socket—or a cumbersome, unsightly aerial? Surely the Ducon! It's so inexpensive—so easy to use—so sure in its results.

★

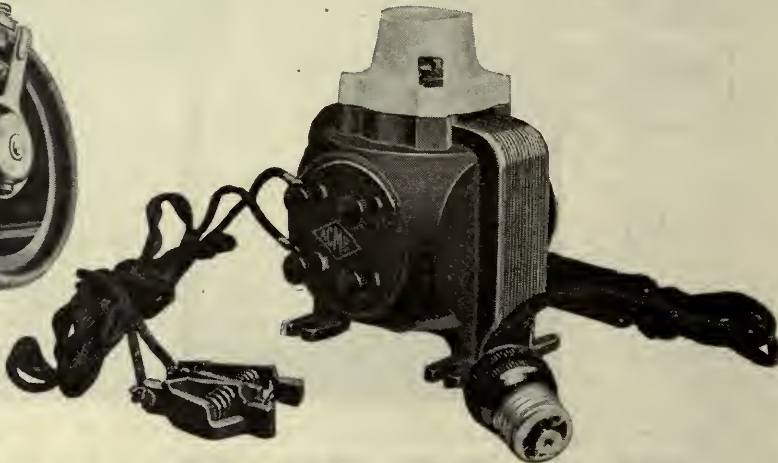
Take home a Ducon to-day—and hear to-night's best programs!

The Ducon is sold by all reliable dealers. Try one for five days. If it is not thoroughly satisfactory, your money will be refunded.

Dubilier

CONDENSER AND RADIO CORPORATION

New Equipment

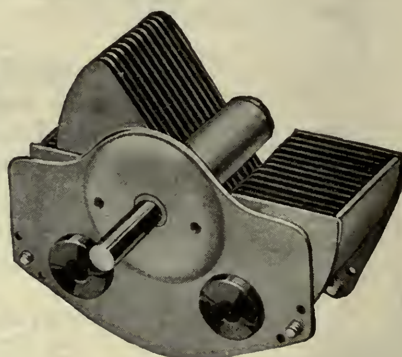


ERLA RHEOSTAT

Designed to require a minimum of room behind the panel and yet it does not sacrifice the good qualities of larger rheostats. The split contact arm facilitates its operation over the resistance winding. It is secured to the panel by a one-hole mounting, a constructional feature now becoming quite popular. Made by the Electrical Research Laboratorties, 2505 Cottage Grove Ave., Chicago, Illinois

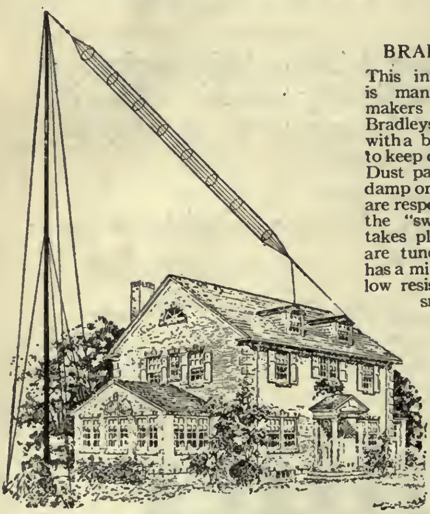
ACME BATTERY CHARGER

This battery charger is one of those units employing a Tungar rectifying tube. It does its work very well, whether it is charging A batteries or high voltage B batteries. The unit is composed of the necessary transformer and connections so that it may be connected directly to the power mains. Made by the Acme Electric and Manufacturing Company, Cleveland, Ohio



BRADLEYDENSER

This interesting condenser is manufactured by the makers of the well-known Bradleystats. It is equipped with a brass shield designed to keep dust from the plates. Dust particles that become damp or electrically charged are responsible for much of the "swishing" noise that takes place when receivers are tuned. The condenser has a minimum of dielectric, low resistance plates and a smooth action



HERCULES AERIAL MAST

The above illustration shows how an efficient and good looking mast may be erected for your antenna. S. W. Hull and Company, 2048 East 79th St. Cleveland, Ohio, make these masts in three standard lengths—20 ft., 40 ft., and 60 ft., all steel construction. They are of a special angle construction that gives great strength and light weight, each of which is a decided advantage. When erected these masts will stand a five hundred-pound pull at the top

SANGAMO FIXED CONDENSERS

These condensers, made by the Sangamo Electric Company of Springfield, Illinois, makers of the well known Sangamo meters, are a distinct addition to the condenser market. They may be thrown on a cement floor without breaking, heated with a soldering iron without changing their capacity, and soaked in water without absorbing moisture. Their capacity is indeed "fixed"

★

Vital to every radio fan

In a radio set, it is the tube that detects the sound—that amplifies the sound—that determines in large part the quality and volume of the sound. Therefore the tube—intricate of mechanism and delicate to make—is the vital spot in every set. And it always pays to be sure you use genuine Radiotrons—made with experienced precision.

Build any circuit—simple or complex. Buy any set, plain or fancy, simply boxed or elaborately cabineted. But give it every chance to achieve its best—with genuine Radiotrons. Be just as careful when you replace tubes, too. *Always* see for yourself that each one bears the identifying marks of a Radiotron: The word Radiotron and the RCA mark.

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THE SOCIAL SIDE OF RADIO

Mrs. Dr. Elliott Norton, center, Frances Peralta, soprano of the Metropolitan Opera Company, right, and Mrs. Alberta N. Burton, at a radio set during the tea-hour. Women throughout the country are finding that they may hear delightful tea and dinner music during the late afternoon and evening, and a radio concert, given by a good orchestra, often adds to the pleasure of a cup of tea

RADIO BROADCAST

Vol. 7, No. 4 August, 1925

From Figures to Fame

Professor Louis Alan Hazeltine Finds that the Algebraic Unknown Quantity, X, Equals Fame, Fortune, and the Neutrodyne

By MYRA MAY

SELDOM, if ever, would any one select algebra as a sure road to fortune. While plumbing, banking, advertising, physics and every kind of concentration are glaringly depicted as a part of the curriculum of most correspondence school courses, it is exceedingly unlikely that these confident advertisers would indicate algebra as the *one* path through which one might attain to Fame and Fortune—that visionary goal of one's dreams. But it has been demonstrated that algebra and Fame and Fortune are somewhat synonymous and that one gains experience from the one branch of mathematics that helps to solve the intricate problems of the higher branch. And so the unknown quantity, X, may, after all, be the Fame and Fortune of your dreams as well as the solution to your involved algebraic equation. It is seldom that one gains Fame and Fortune through the direct application of mathematics, however, and, student or scholar, he is fortunate, indeed, who, having solved his algebraic problem, finds that the X, literally spells Fortune itself. Such was the case with Louis Alan Hazeltine, inventor of the "neutrodyne" circuit.

PROFESSOR LOUIS ALAN HAZELTINE

Inventor of the neutrodyne circuit, embodied in thousands of receivers used all over this country and abroad. Mr. Hazeltine is head of the Department of Electrical Engineering at Stevens Institute of Technology at Hoboken, New Jersey, and is here shown using a wavemeter in his laboratory

If someone were to ask you why radio interested you, you might reply that you liked to try for distance, or that you enjoyed the enter-

tainment that a full program affords, or you might, like Professor Hazeltine, answer that it is the science of radio which interests you. Professor Hazeltine explains that it was the opportunity to work out mathematical problems that first led him to experiment with radio. He has never been especially interested in either the programs of broadcasting stations or in attempts to receive long distances. He has been concerned with little but the scientific side of wireless. It is characteristic of the man that he did not have a neutrodyne set himself until several years after he had worked out the fundamental theory mathematically and had made application for his patents.

PROFESSOR HAZELTINE LIKES MATHEMATICS

"MATHEMATICS has always been a favorite of mine," he says. "At school I once received a prize for my good work and my highest grades were always in mathematics. By chance, I graduated first in my class, but that was only by chance, for I had consistently held second place until the leader went to live in another city. From a high school in New London, Connecticut, I transferred to Stevens Institute of Technology where in 1906 I graduated with the degree of Mechanical Engineer."

Professor Hazeltine is too modest to tell that he finished his school and college course in twelve years instead of the sixteen most of us give to it. He prefers to let people find that out for themselves.

"I remember," he reminisces, "when I was a little boy I saw my uncle working out some algebraic calculations: he explained that he made those queer hieroglyphics just for amusement. I marvelled at such a pastime when there were such sports as baseball and swimming to claim spare hours. I had no premonition that some day I, too, would devote my leisure to the same queer hieroglyphics.

"When I entered Stevens Institute I did not know what branch of engineering I wanted to take up, but I did know that I had a prejudice against electrical engineering. Nevertheless, near the end of my course I began to feel that the performance of electrical apparatus could be predetermined more accurately than that of mechanical. It was this feeling that led me to change my field to electrical engineering in spite of my former prejudices, and later, it was this same feeling that led me to specialize in radio."

After graduating from Stevens Institute, Professor Hazeltine entered the testing department of the General Electric Company in Schenectady where he received a practical training. This was his only venture along the highroad of business, for the following year he was offered a position as assistant in the Department of Electrical Engineering at Stevens Institute and he has remained at that college ever since.

WHY HAZELTINE SPECIALIZED IN RADIO

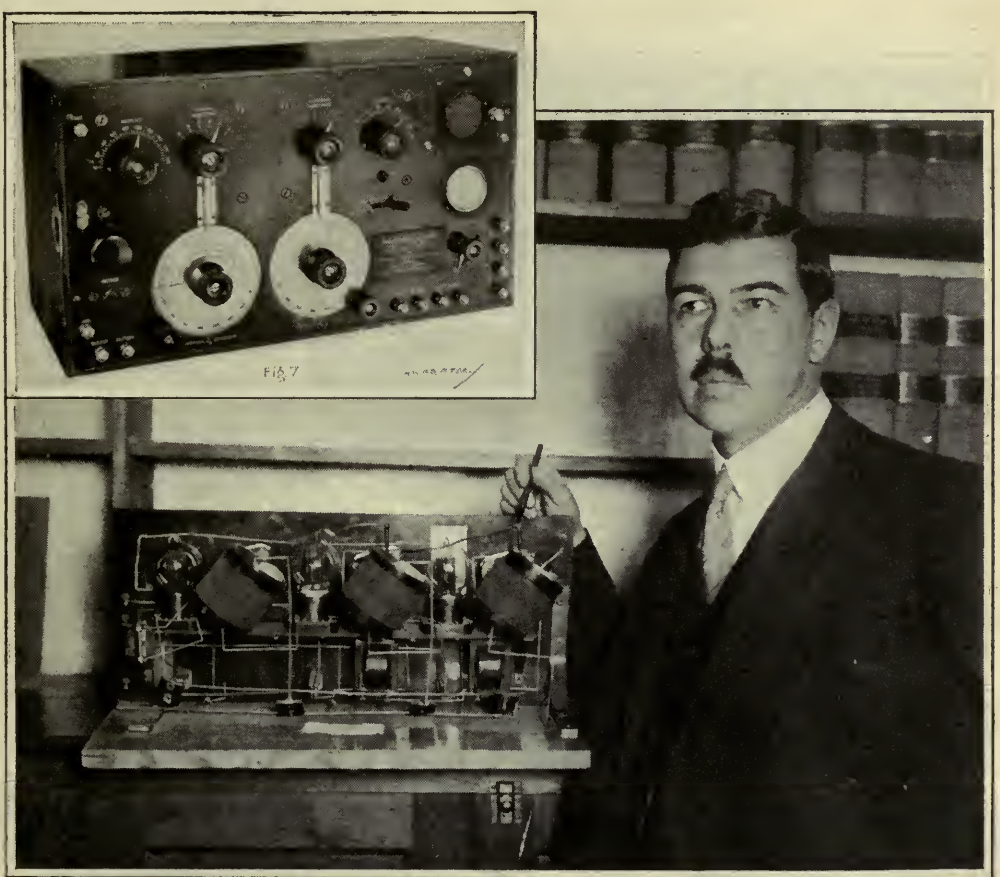
"I WAS fortunate in my surroundings at Stevens," says Professor Hazeltine, "for my work covered all branches of electrical engineering and the head of the department, Professor Albert F. Ganz, was always aiding and inspiring my further progress. During this period I specialized in one branch of electrical engineering after another, and prepared much of the material for presentation to my classes. It was in this manner that I gradually developed a text on electrical engineering, which has but recently been published.

"Professor Ganz was the foremost authority in this country on the subject of electrolytic corrosion of underground structures by stray electric current, particularly from electric railways. At times I assisted him in this work and for several years after his death I was associated with the firm of Albert F. Ganz, Incorporated, which continued his professional work in electrolysis."

During the winter of 1914-1915, the well-known radio experimenter, E. H. Armstrong, wrote a paper, presented before the Institute of Radio Engineers, on the fundamentals of the three-electrode vacuum tube and then in a subsequent paper described in detail the tube's capabilities for oscillating which he had discovered. The young instructor at Stevens, who had always been partial to any branch of mathematical science, found a new and delightful field before him. Here at last was a real opportunity to apply mathematical analysis.

THEORY PRECEDES PRACTISE

LONG before Professor Hazeltine had one of the desired vacuum tubes he began a theoretical study of its operation, and it was in this manner that he worked out the theoretical requisite for the production of oscillations. Not until then did he obtain a vacuum tube (then known as an audion) to trace its characteristic curve. On the basis of that information he designed his circuit, wired it, and immediately obtained the anticipated result.



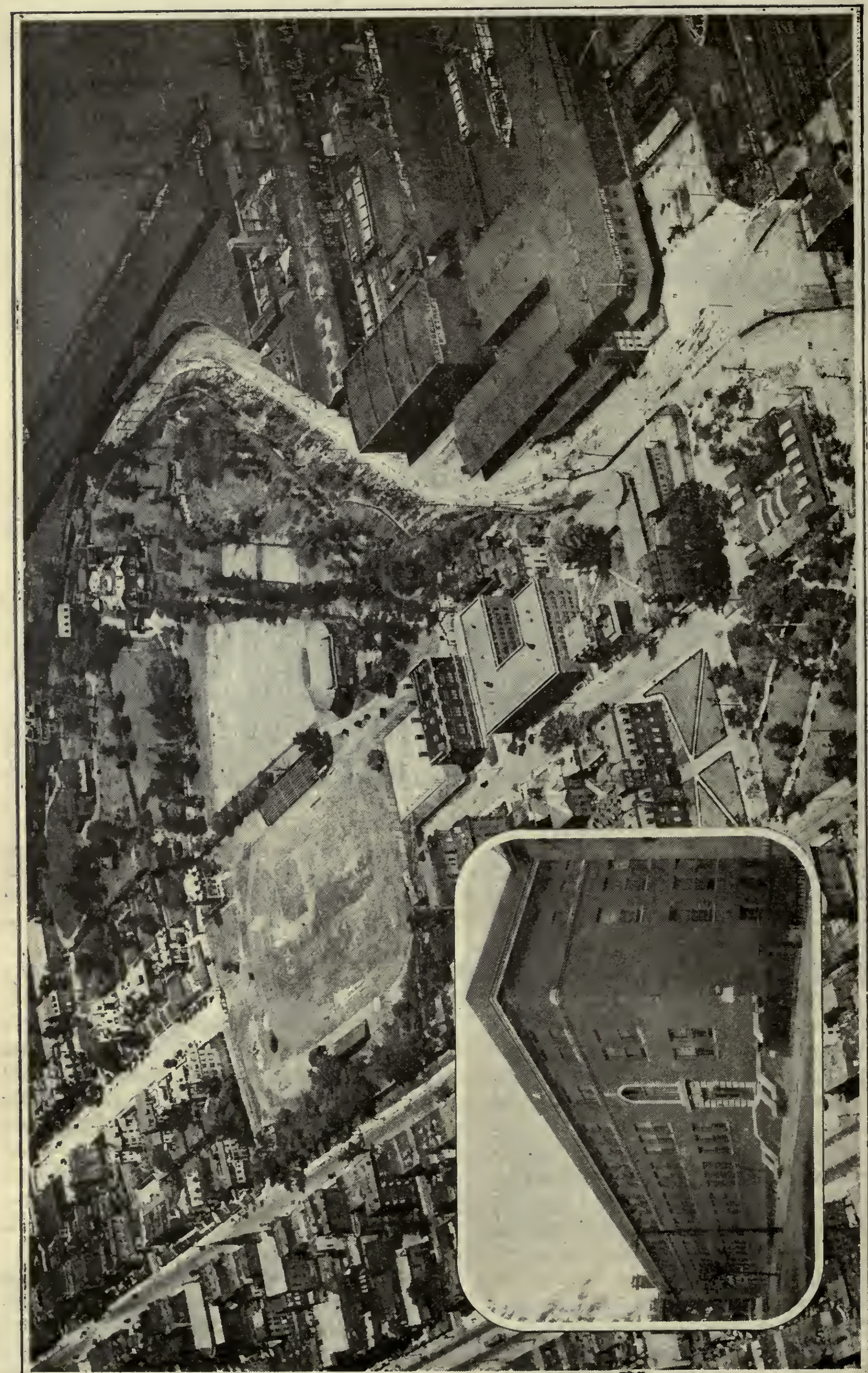
TWO RECEIVERS

Designed by Professor Hazeltine. The one in the insert was designed for the Navy Department during the war and is known officially as the SE 1420. It was while he was developing this receiver that the idea for the neutrodyne circuit was partially evolved. The larger photograph shows Mr. Hazeltine and one of his models of the neutrodyne

In spite of this remarkable performance, Professor Hazeltine continued his theoretical studies coupled with experimental verifications for the next two years, and it was not until 1917 that he felt that his work was in sufficiently perfect form to give it to the world. His paper on "Oscillating Audion Circuits" which gave the results of his investigations was read before the Institute of Radio Engineers. This was the first time that a general and yet a simple mathematical method for the treatment of oscillating audion circuits had been given. It was in this paper that Professor Hazeltine used the expression "mutual conductance," a term that has since become as much a part of radio language as have antennas and batteries. Professor Hazeltine asserts that all of his subsequent radio work and whatever success he has achieved may be traced to that paper.

Wireless was claiming more and more of Professor Hazeltine's time. The following summer he devoted to experimental work in radio telegraphy and telephony in conjunction with Mr. Paul Ware. Later Mr. Ware joined the Signal Corps of the United States Army where he continued his research and produced a valuable portable set that has since been adopted as a standard equipment by the Signal Corps.

Meanwhile Professor Hazeltine was also conducting a radio and buzzer class to train operators for the Signal Corps. And then when Professor Ganz died, Professor Hazeltine was appointed in his place to serve as head of the Department of Electrical Engineering.



AN AIRPLANE VIEW OF STEVENS INSTITUTE

Of Technology, in Hoboken, where Professor Hazeltine teaches. Hudson River piers can be seen to the right. The insert shows the Electrical Engineering building

THE SE 1420

DURING the following year I was asked to join the technical staff of the radio laboratory at the Navy Yard at Washington," he narrates. "I spent the summer in Washington doing miscellaneous development work and in the early fall I designed a radio receiver which was standardized by the Navy Department and has been in wide use ever since. To Naval operators it is known as SE 1420. This receiver contained several novel features, and its design was of particular interest to me because it was based on the theoretical formulae which I myself had evolved and which were incorporated in my paper on 'Oscillating Audion Circuits.' These methods were borne out so well by experiment that only a single shop model was constructed on which a few minor adjustments had to be made before the final drawings and specifications were prepared for the submission of bids.

"In the midst of my work I was stricken with an attack of influenza which kept me away from the laboratory for a few weeks. On my return I found that another member of the technical staff had practically completed the development of a receiver similar to my own. The officer in charge of the work, Lieutenant W. A. Eaton, suggested that I abandon my development on the ground that time was pressing and that the other receiver was nearly ready. Had he given me definite instructions I would, of course, have obeyed him. But inasmuch as he merely expressed a wish that I do so and because I had great confidence in my own design, I felt justified in continuing with my work. The result was that when these receivers were tested mine was shown to be distinctly superior to the other and it was eventually adopted. Although it is strictly against the copy-book traditions I feel that a subordinate is justified in going against the wishes of his superior if he is confident that he is right and if he is not disobeying positive instructions.

ELIMINATING CAPACITY COUPLING

IN THE design of this Navy receiver I was particularly interested in trying to eliminate capacity coupling between the primary and the secondary circuits, for experience had shown me that this was a source of much interference in reception. By suitable shielding I was able to eliminate all capacity

THE STAFF OF THE ELECTRICAL ENGINEERING DEPARTMENT
Of Stevens Institute of Technology. Professor Hazeltine, head of the Department, is seated in the first row, center. Front row, left to right, Professor F. C. Stockwell, Professor L. A. Hazeltine, W. P. Powers. Back row, H. L. Paulding, V. C. McNabb, Samuel Slingerland, and H. C. Roters

coupling in the primary and secondary circuits except between two coils, one of which was necessarily in the field of the other. Then it occurred to me that I could minimize this coupling by partially shielding one of these coils through an auxiliary coil wound over it. I realized that this coil would pick up some current, and I quickly saw that this current might be employed to neutralize whatever capacity coupling remained. This was the first thought of capacity neutralization that I had, and I did not realize at the time that it was destined to be what one might call the keystone of the neutrodyne. The neutralization was actually incorporated in the Navy receiver although it was of the nature of a refinement rather than of a necessity.

"Later I attempted the design of an audio-frequency amplifier which would give a particularly high amplification, but after a time I came to the conclusion that such an amplifier would oscillate persistently on account of the capacity coupling between the plate and the grid of the vacuum tube, in its circuit, for the plate and the grid circuits would be connected to similar transformers and would therefore be in resonance—a condition particularly conducive to oscillation. Almost at once I saw the solution—the deleterious capacity coupling. I suppose that my experience with the Navy receiver helped me to reason out the method which I thus evolved. My experience seems to me to be an illustration of the adage that the realization of a problem is frequently more important and more difficult than its solution. This neutralization of capacity coupling in vacuum tubes was the basis of the neutrodyne circuit, the practical development of which came several years later.

THE WAY TO SOLVE PROBLEMS—SOLVE THEM

IN 1919 I started to devote my time to a study of the application of three-electrode vacuum tubes to the various problems of power conversion, with efficiency the primary object. This work was to some extent a continuation of my earlier work on oscillating circuits, for the form of conversion which I first investigated was from direct current to high-frequency current as used for radio transmission. The work was carried on much further, however, in order that it might include conversion of alternating current power into direct current power, of one frequency into another frequency, of direct current into alternating current of controllable frequency, and so forth. This new subject was a valuable background for my other work and made me realize that although two problems might not be closely related, they might, nevertheless, have a common ground in their respective solutions.

"In my college work I constantly see many boys who seem quicker than I in absorbing mathematical theories, but they have not the fondness for work that leads to original investigations. I have long believed that the prime requisite for success along mathematical lines—and this applies to all scientific progress—is not so much a natural ability, as it is a certain fondness for the subject. The only way to learn to solve problems is to solve them.

"I was engaged in the development of radio receivers during the fall of 1922 when my attention was directed to the immense possibilities of a receiver employing tuned radio frequency amplification. I knew that the great limitation of this type of receiver, which had thus far prevented its successful introduction, was in its strong tendency to oscillate because of the feed-back of the capacity coupling of the vacuum tube. This feed-back was accentuated by the tuned input and output circuits. I realized that my earlier work on the neutralization of this capacity coupling was directly applicable. A model receiver was constructed to incorporate these ideas and it was christened the neutrodyne.

"During this period, several manufacturers were eager to obtain a receiver of this sort, and Mr. I. P. Rodman, an officer of the present Garod Corporation who had become convinced of the great value of a tuned radio-frequency amplifier, had much to do with its development. The neutrodyne was first brought before the public at a meeting of the Radio Club of America in March, 1923.

HOW INVENTIONS ARE MADE.

THERE is much curiosity as to how inventions are made. In the earlier development of an art, most inventions are the results of experimental discoveries, and this is often the case even in their subsequent growth. For example, Armstrong's inventions of regeneration and super-regeneration come under this category. My inventions, on the other hand, have all been the result of theoretical studies, verified and modified by later experimental work. Again some inventions are the result of mathematical analysis as, for example, Pupin's and Campbell's loading coils on electrical filters in telephone lines. Although I have used mathematical analysis

PROFESSOR HAZELTINE AND A CLASS

At work in a laboratory in the Department of Electrical Engineering at Stevens Institute at Hoboken, New Jersey

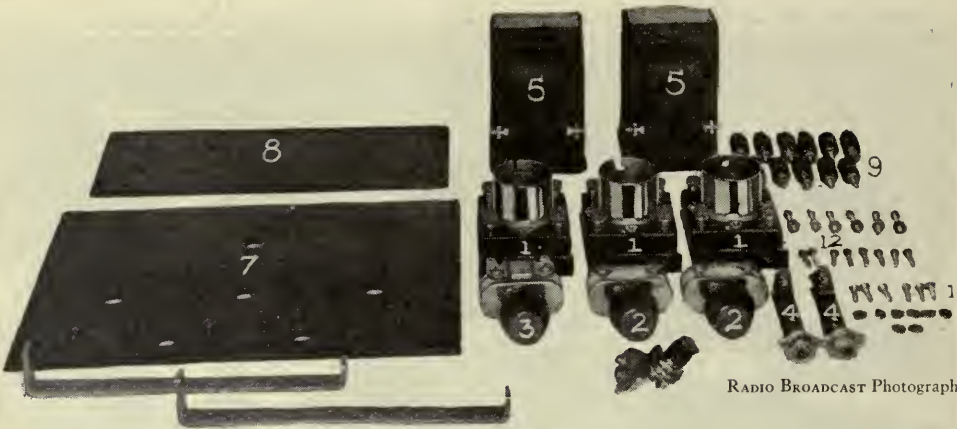
quite freely in my studies, it so happens that my inventions have been based on elementary technical considerations and can be fully described either with or without the most elementary sort of mathematics.

"Some inventions are made deliberately; that is, the inventor has a problem before him which he attacks in every way that he can think of until he solves it. It was in this manner that I made my invention of capacity coupling neutralization as applied to vacuum tubes and my high efficiency arrangements for power conversion with vacuum tubes.

"It is interesting to compare the problems which confronted the engineers of a few years ago with those which puzzle them to-day. In the days immediately following Armstrong's regenerative work, the great problem was to get vacuum tubes to oscillate, and I have spent many hours in trying to produce oscillations in circuits where the conditions were essentially unfavorable. In the Navy receivers which preceded mine, the idea of obtaining oscillations under all conditions of coupling and wavelength had been definitely abandoned and it required all of the refinement of calculation of which I was capable to produce controllable oscillation in my own receiver.

"The problem of tuned radio frequency amplification, however, has been solved by the elimination of oscillations and I have spent as many hours getting rid of stray coupling and thereby stopping all tendency to oscillate as I have previously devoted to the encouragement of oscillation. So radio progresses."

It may be that Professor Hazeltine has used the same method of progress for himself. In any event, he has come up by almost pure mathematical processes to vindicate the student. He has made inventions that others have repeatedly failed to approximate, and he has placed himself in the foreground of important figures in the technical world to-day.



Radio Broadcast Photograph

FIG. 1

A parts picture. With the exception of the fixed condenser, all the parts entering in the construction of the detector amplifier are shown here. The numbers correspond with those of the parts list

How to Build a Two-Stage Detector-Amplifier Unit

By JOHN B. BRENNAN

WE BELIEVE that radio constructors are becoming more and more interested in building receivers that will produce signals of excellent quality. As Mr. Brennan, technical editor of this magazine, brings out in this article, it is not now so important just how much noise a receiver will deliver, or how far it can be heard, but the quality of the program it produces. . This unit, which is designed to fit with the two-stage radio-frequency amplifier unit described by the same author in this magazine for May, 1925, has been especially designed to give the best possible quality. The cost of parts is not high, and the constructor will find that assembly and wiring is quite easy.—The Editor

SLOWLY but surely the trend in radio is swinging toward quality. We are learning that it is not how much, but how good that counts in radio.

There was a time when the radio store which had the largest horn sticking out its front window with a power amplifier behind it, assumed a kind of local radio supremacy due entirely to the pure force of the racket. Times have fortunately changed, and to-day we see many dignified if modest radio establishments equipped with individual listening-in booths where receivers are on display and demonstration.

So, too, the change has been felt in the design of radio apparatus. Parts and complete sets have been materially improved. Good voice and music quality and perfectness of loud speaker reproduction have assumed their rightful importance in design and construction. That old term "tremendous loud speaker volume" is slowly slipping into the discard. It is being helped along by an occasional shove in the form of an amplifier which produces loud speaker signals with clarity and fidelity.

This paper describes such an amplifier.

WHAT DO WE WANT IN AN AMPLIFIER?

TO BE efficient, a detector and amplifier must have the qualifications of sensitivity, honesty of reproduction, ease of control, and must produce loud speaker volume sufficient for dancing. Its construction must be simple.

The sensitivity largely depends upon the type of tuner employed to tune the incoming

signal before it reaches the detector tube. However, the detector tube must also be possessed of qualities which will make of it a sensitive rectifier of these signals.

Honesty of reproduction, or in other words, the property of the amplifier to repeat faithfully the sounds as transmitted, is a function governed by the selection of a suitable audio-frequency transformer, plus the intelligent use of A, B, and C batteries.

All detector-amplifier circuits are pretty much alike. Their differences are mainly in the design which affects the control of the various parts entering into the construction of a completed unit. Undoubtedly a unit may be produced in which everything possible is variable: C battery adjustment to the amplifiers, grid leak, grid condenser, tapped transformer primaries and secondaries, and B battery voltages. It is hardly necessary to state that the tubes would be individually controlled by separate rheostats. However, a unit such as this would soon loose its value if it were to be used in a permanent installation where there would be no need for all these controls once a satisfactory adjustment has been obtained. Such a completely variable unit would rather be suitable for the laboratory.

The volume produced by an audio amplifier depends upon the number of stages of amplification which may safely be used without overloading the amplifier tubes. Volume also depends upon the sensitivity of the detector and the ability of the amplifier to take whatever is produced in the detector and amplify it without altering the signal characteristics. Briefly explained, this means that some amplifying transformers have the tendency to favor some voice and music notes over others, depending upon the electrical and mechanical makeup of the transformer. The distributed capacity in transformer windings causes a favoring of the lower frequencies over the higher frequencies. Also, when little iron is used in the core construction, it becomes over-saturated by the forceful variations of electromagnetic flux and prevents the transformer from functioning successfully.

GOOD QUALITY AND SUFFICIENT VOLUME

THE detector and two-stage audio-frequency amplifier described here is the result of experimentation along the lines as explained above. It has been reduced to a practicable working unit producing a very high quality of signal with plenty of volume.

This detector-amplifier may be used with any tuner now available, but has been especi-

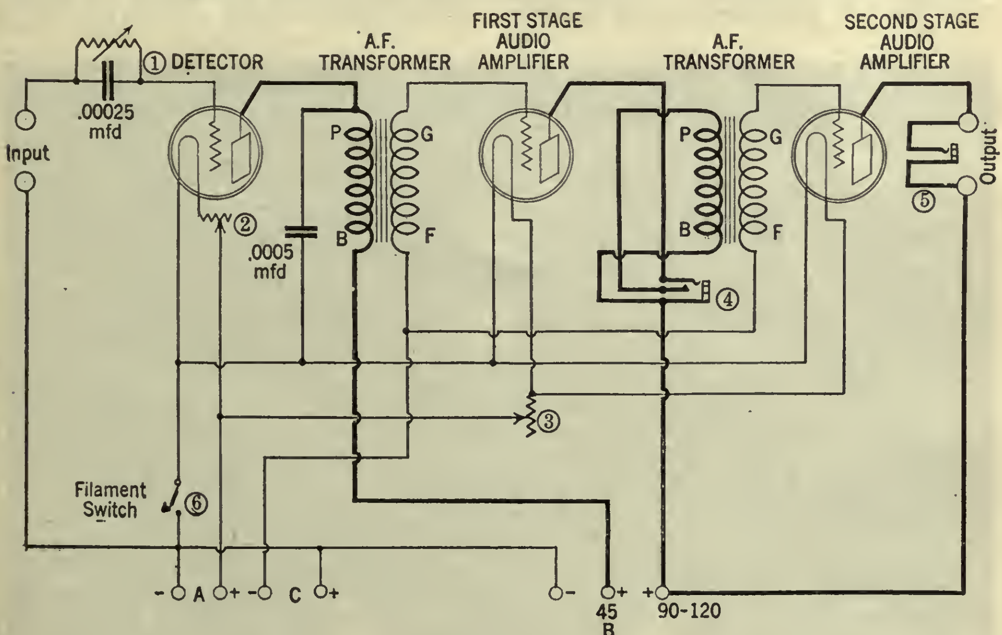
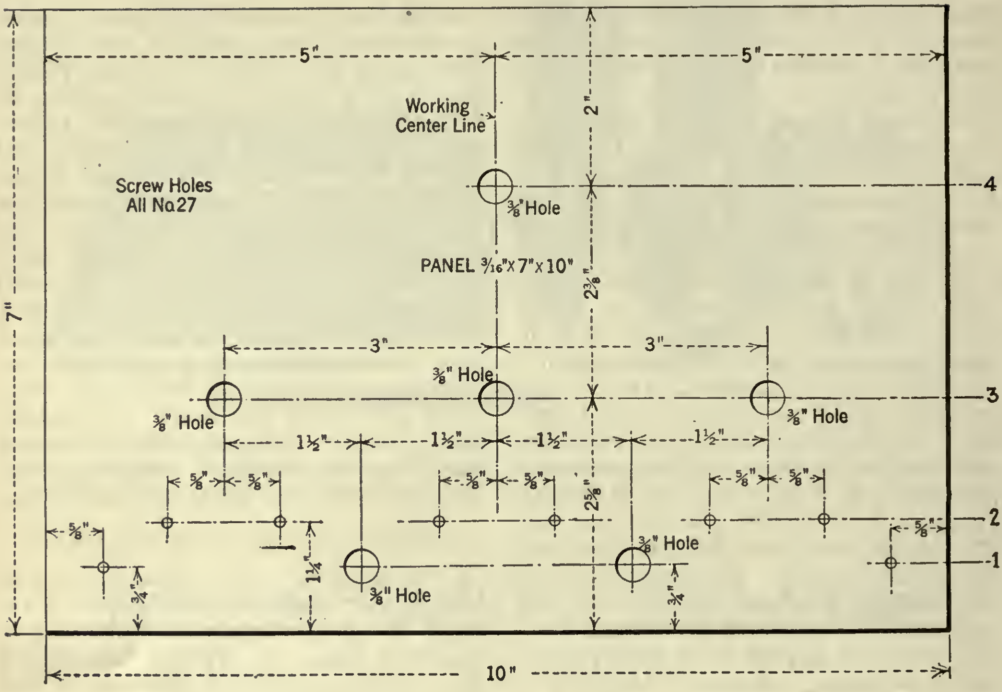


FIG. 2

The circuit of the detector-amplifier. The numbered units refer to those panel controls as marked on the panel illustration Fig. 3. In wiring it is well to make frequent use of this circuit and the schematic wiring diagram, Fig. 7



FIGS. 3 AND 4

This front view of the panel indicates the symmetrical layout which has not caused any sacrificing in efficiency for the sake of appearance. Ample room on the upper side allows for the mounting of a filament voltmeter and plate milliammeter or plate voltmeter. The working drawing above shows the panel layout

RADIO BROADCAST Photograph

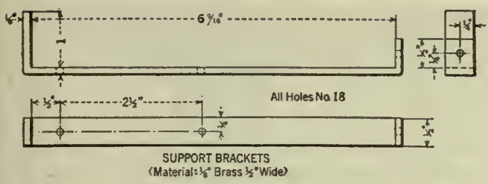


FIG. 6

The angle bracket details. Two are required

ally designed as the audio unit for the two stage radio-frequency amplifier described in the May, 1925, RADIO BROADCAST.

The circuit comprises a vacuum tube detector with variable grid leak and independent filament rheostat and a two-stage audio amplifier with filament controlled by one rheostat. Large core audio-frequency transformers of a ratio of approximately 3 to 1, and a C battery bias upon the grids of the amplifying tubes are important items entering into the construction. None of the adjustments is exceedingly critical but are found to be of actual necessity when maximum service is desired.

All the binding posts for the connection of the tuner, batteries and loud speaker are mounted upon the rear of a bakelite shelf which also supports the audio transformers.

A filament switch, the grid leak and condenser, rheostats, sockets and jacks are mounted upon the panel. The bakelite sub-base is mounted upon the brass angle brackets which are fastened to the back of the panel.

WHAT PARTS TO USE IN THIS UNIT

SATISFACTORY results with this design depend entirely upon the selection of many of the same parts as employed in our construction. This is quite logical. It is probable that another type of amplifier can be designed using other parts—but that's another story.

The parts employed in the construction of this unit are listed as follows:

1. 3 Federal sockets—panel mounting
2. 2 Bradleystats
3. 1 Bradleyleak, with .00025 mfd. condenser
4. 2 Carter Jacks, 1 open single-circuit, 1 closed single-circuit
5. 2 Rauland Lyric audio-frequency transformers ratio 3.95 to 1
6. 1 Carter filament switch
7. 1 Panel 7 x 10 x $\frac{3}{16}$ inches
8. 1 Panel $3\frac{1}{2}$ x $9\frac{3}{16}$ x $\frac{3}{16}$ inches
9. 10 Eby binding posts
10. Brass strip 20 x $\frac{1}{2}$ x $\frac{1}{8}$ inches
11. Bus wire—lugs
12. 14 $\frac{1}{2}$ inch x $\frac{6}{32}$ Round head machine screws with hex nuts.
13. 6 $\frac{1}{2}$ inch x $\frac{6}{32}$ Flat head machine screws with hex nuts
14. 1 – .0005 mfd. fixed condenser

The reader will probably ask, "can other transformers be used instead of those shown?" Of course, yes, but so can other parts be used throughout the construction. If this variation is allowed in parts selected, the individual constructor would have to lay out his own job. He would, of necessity, have to rearrange the

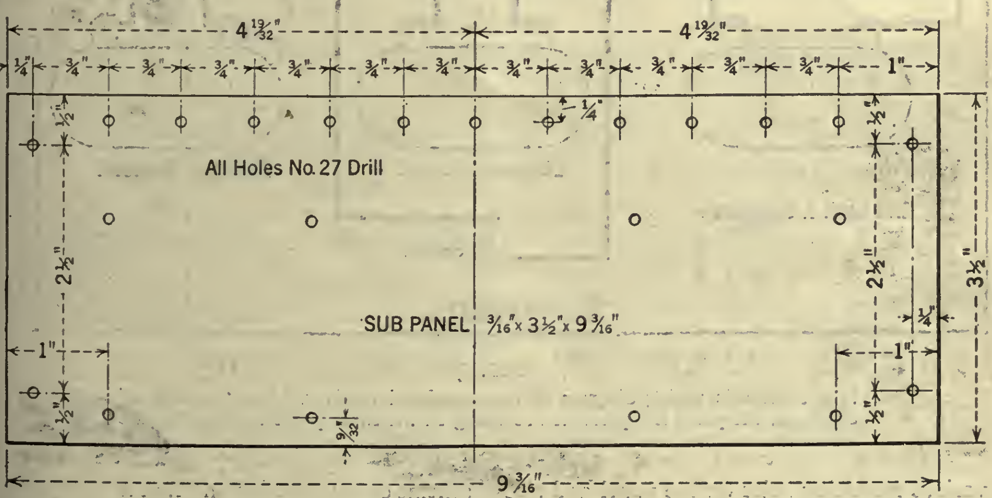


FIG. 5

In the layout of the sub-base, the dimensions are marked starting from the center line. By actually placing the audio transformers in place, their mounting holes may be scribed

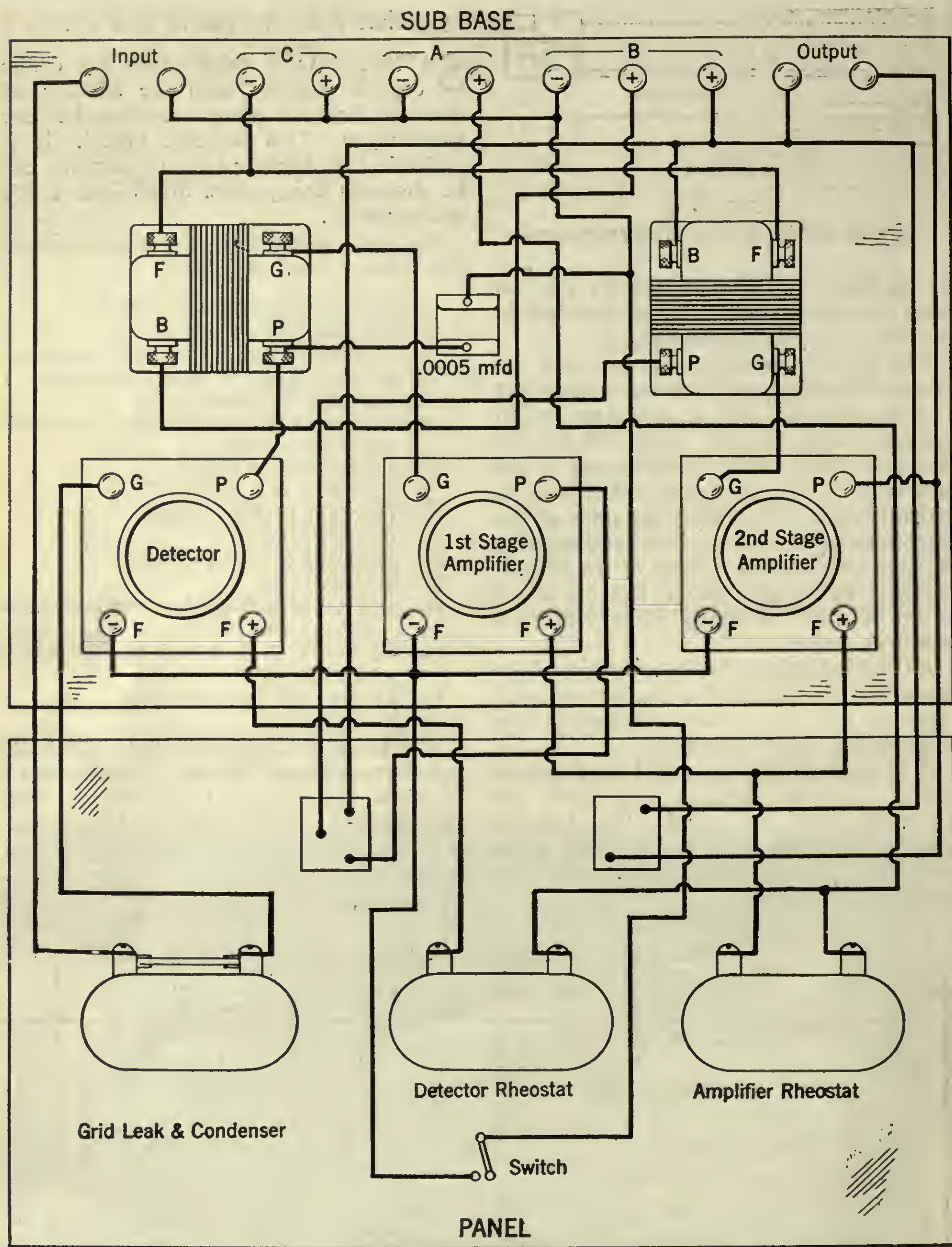
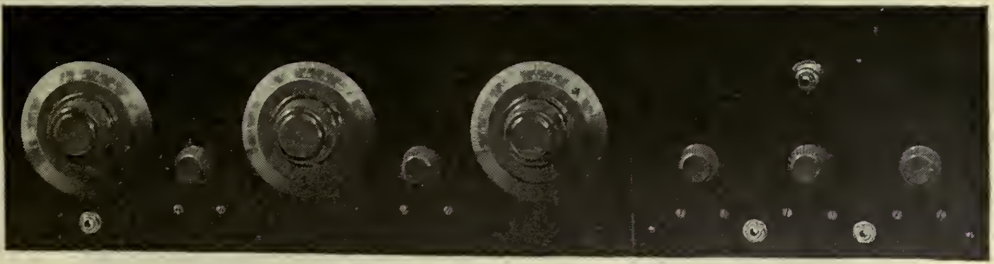


FIG. 7

Is a schematic wiring diagram of the completed receiver. For the sake of clearness, the panel is represented as being on the same plane as the sub-base

various mounting holes on the panel and also the sub-panel holes would be changed.

If the parts were not thoughtfully selected there would be nothing left but the idea and scheme of construction and that is hardly new. Therefore for those who wish to benefit by the experience gained in the test of several types of apparatus, it is suggested that they con-



Radio Broadcast Photograph

form to the selection of parts as closely as possible to the list as shown.

The heart of the unit is the two audio-frequency transformers. They have been selected because of the large cores upon which are wound plenty of wire. These two features alone prevent over-saturation and insure against overloading.

In laying out the panel, place it face down on a table with its length running right and left. Now divide the length into two sections evenly, both of five inches each. The dividing line is the working center line. Working up, three quarters of an inch from the bottom scribe a line (1) across the length of the panel. On it will be located the two jacks. Then one half inch above it scribe another line (2) all the way across. This is for the socket mounting holes. Another line (3) is scribed

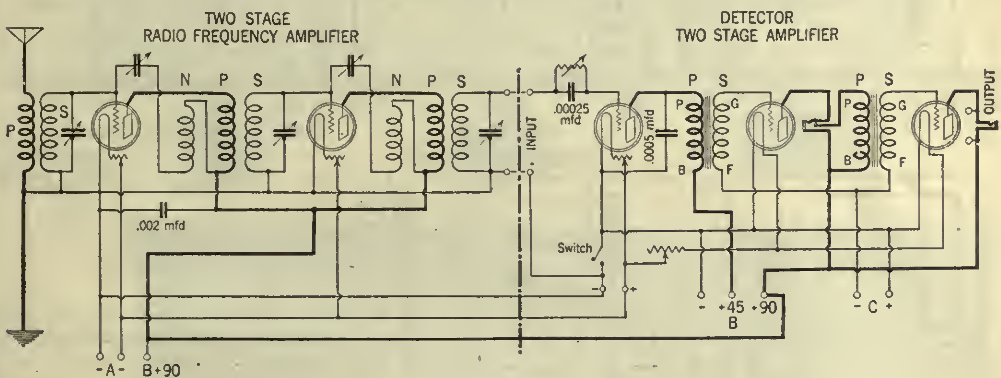


FIG. 8

How the detector two-stage amplifier would be connected to the two-stage radio-frequency amplifier described in the May, 1925, Radio Broadcast. The cut above shows the two units connected

Those used in this amplifier are of a low ratio and are capable of taking a very strong signal and amplifying it without changing its characteristics. The circuit employed is that of Fig. 2.

The numbered symbols in Fig. 2 are those with variable controls that are mounted on the panel. They may be identified in the panel illustration Fig. 3.

ASSEMBLY IS EASY USING THE NUMBERS

THE construction of the detector-amplifier is almost entirely a matter of assembly, and wiring. We suggest proceeding as follows:—After the parts have been obtained, the panels are prepared by drilling all the holes and graining the surface by rubbing with fine emery paper.

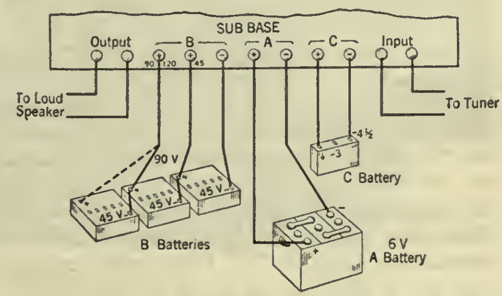
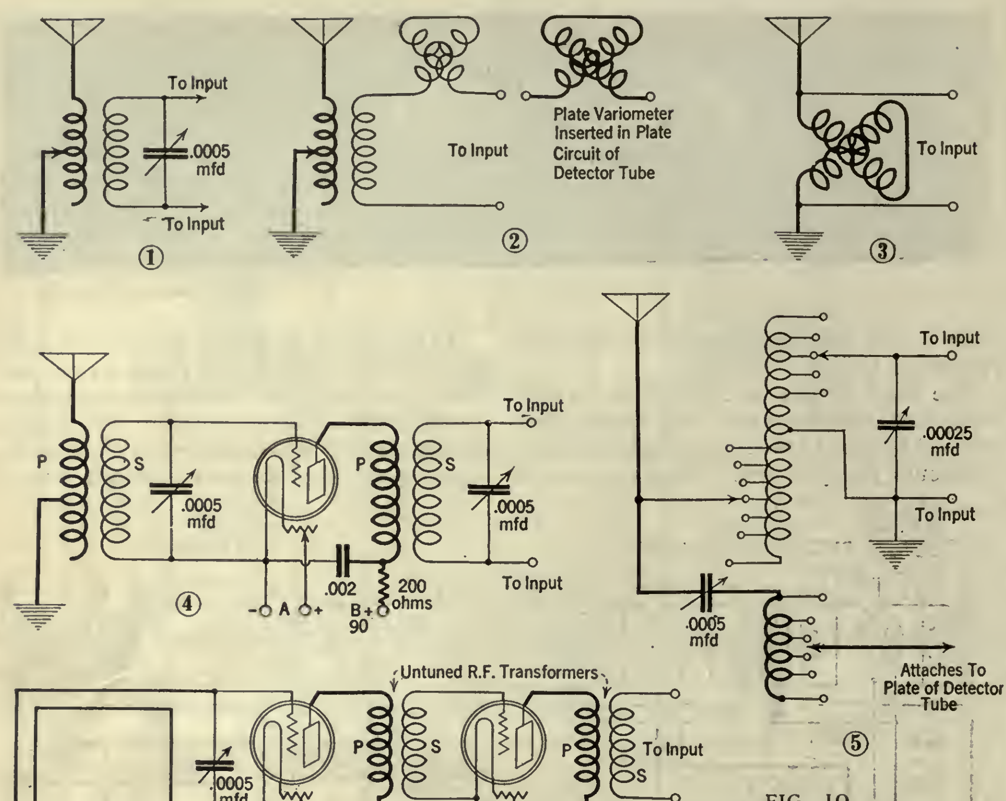


FIG. 9

Here is how the batteries, A, B, and C are connected to the binding posts on the sub-base



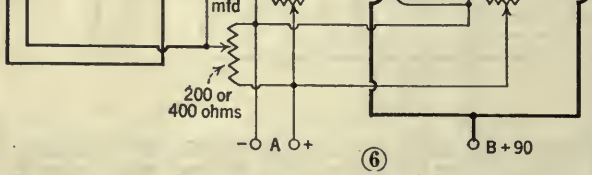


FIG. 10

Several tuner and radio-frequency amplifier circuits which may be used with this detector amplifier. 1, is a standard tuner with primary and secondary, the latter shunted by a .0005 mfd. condenser; 2. is the old standby, the variometer-variocoupler tuner; 3. is the variometer antenna tuner; 4. a non-radiating radio-frequency amplifier and tuner; 5. the Reinartz tuner; and 6. a loop and r. f. circuit. In the detector circuit, the return of the grid circuit is made to the negative side of the A battery line. If results are not satisfactory, try making this connection on the positive side of the A supply

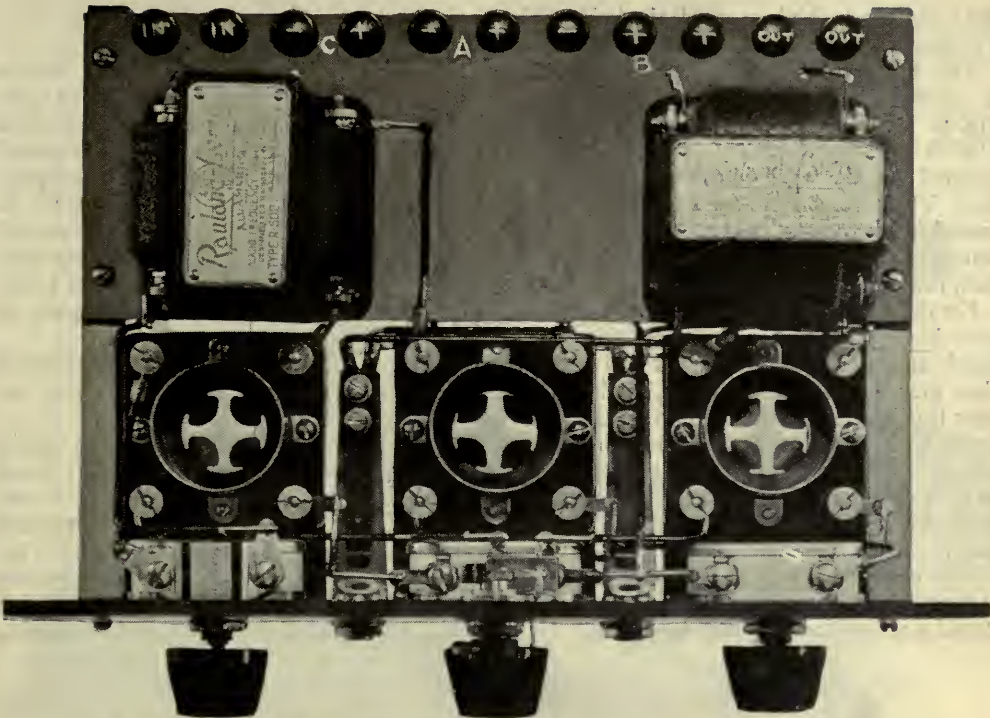
$1\frac{3}{8}$ inches above the last one for the grid leak and two rheostats. The filament switch hole intersection line (4) is marked directly on the center line $2\frac{3}{8}$ inches above the line No. 3.

Working out from the center line on line No. 1, the two jack holes are located $1\frac{1}{2}$ inches away. The mounting holes for the brass brackets are located on this line $\frac{5}{8}$ of an inch from the sides of the panel.

Now jump up to line No. 3 for the rheostats and grid leak, etc. One is centrally located on the center line and the other is 3 inches to the side as is the grid leak hole. After locating these three points, continue the scriber lines down so as to interesect line No. 2. Then coming back to line No. 2 the socket mounting holes are located $\frac{5}{8}$ of an inch either side of the point of intersection of the rheostat hole lines. The complete layout is shown in Fig. 4.

This completes the panel. The sub-base dimensions may be laid off in a similar manner and are shown in Fig. 5.

The binding posts are situated three quarters of an inch from each other beginning at the center line. The holes for screws holding the sub-base to the brass brackets are located on each end $\frac{1}{4}$ of an inch in from the edge. The transformer holes are given but are not accurate for all transformers of the same manufacture. Therefore, in laying out these holes it is well to place the transformers on the base so that the holes on one side are $\frac{9}{32}$ of an inch from the front edge. Then holding



RADIO BROADCAST Photographs

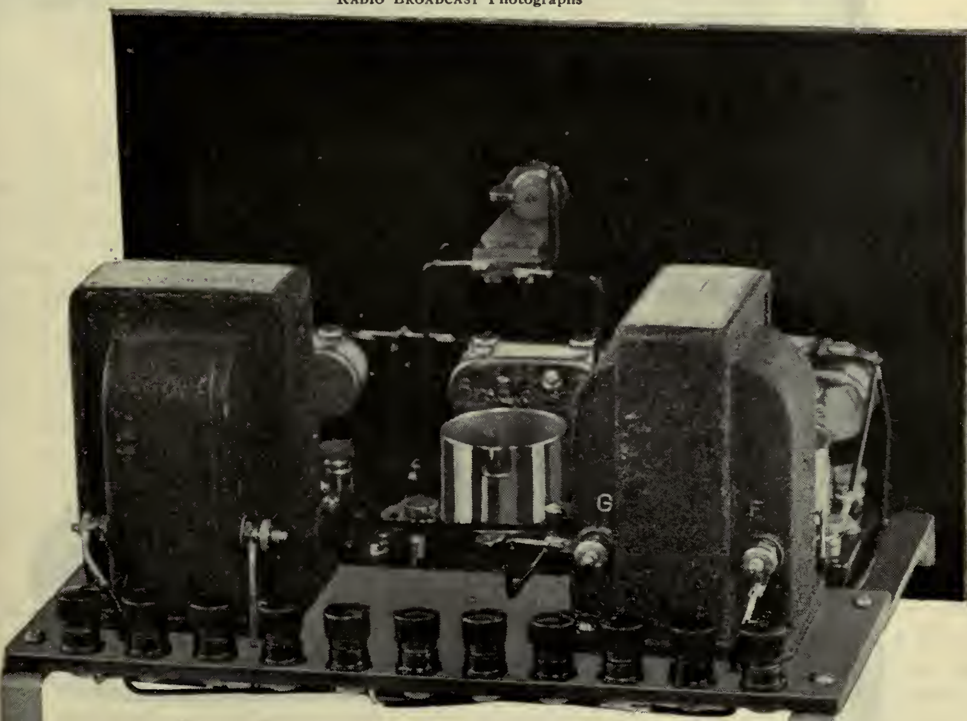


FIG. 11 AND FIG. 12
The top side with all parts excepting the bypass condenser in view. Note how the two audio transformers are mounted with their cores at right angles to each other. Much of the wiring is on the under side of the sub-base

the transformer in place, mark the holes with a scriber.

The brass brackets are bent and drilled in accordance with the layout shown in Fig. 6.

With this preliminary preparation accounted for, the work of assembly is next in line. The several parts are mounted in order named, from the top of the panel down; first filament switch, then rheostats, and grid leak, next sockets and finally jacks.

For the sub-base, first mount all the binding posts having the lugs on the under side of the panel and pointing in toward its middle. Next mount the panel upon the brackets and after this is done, secure the two transformers firmly with $\frac{1}{2}$-inch x $\frac{6}{32}$ round head machine screws. The cores are placed at right angles to each other as may be seen from the schematic wiring diagram Fig. 7 and the illustrations.

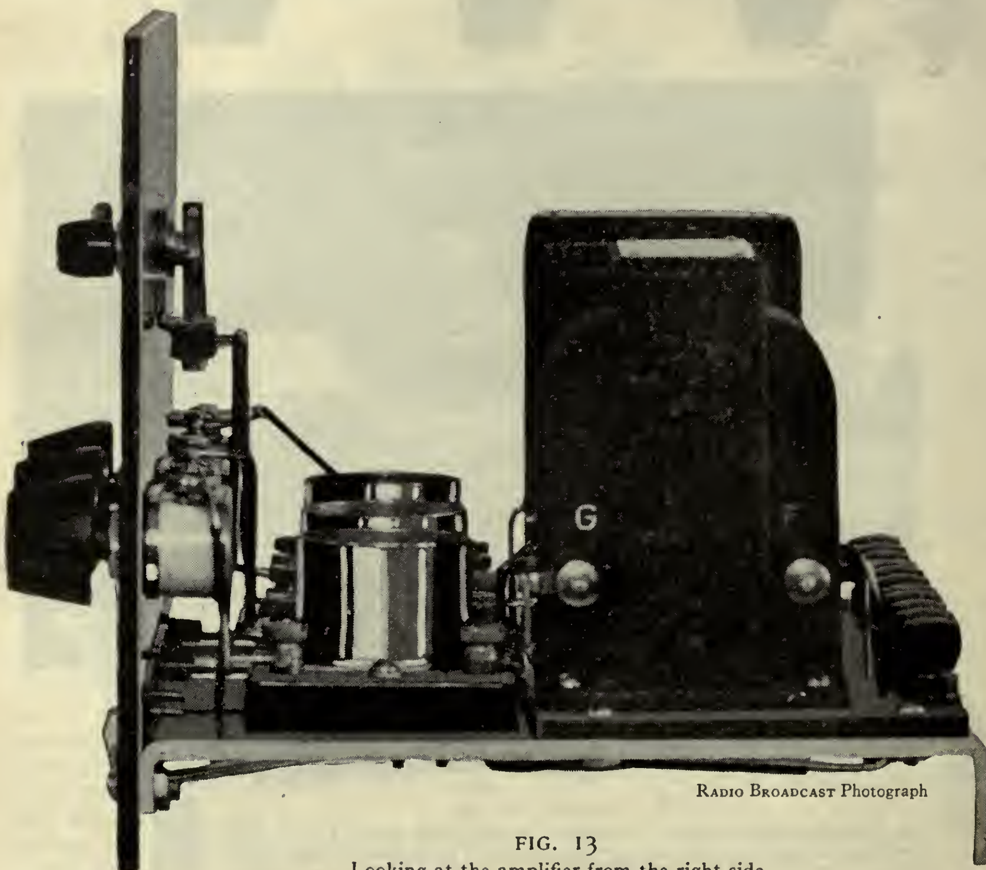
The completed sub-base unit is fastened to the panel by two round head brass or nickel plated machine screws $\frac{1}{2}$ inch long.

THE UNIT

IN AN assembly job as compact as this, it is absolutely essential that insulated wire be used, at least where there is danger of short circuits. In the unit described, insulated wire has been used throughout. Contrary to what one might think, the wiring job is simplicity itself. It is only to be remembered that the wires should run direct from one part to the other without unduly twisting or bending them. The schematic wiring diagram in Fig. 7 will be of aid here.

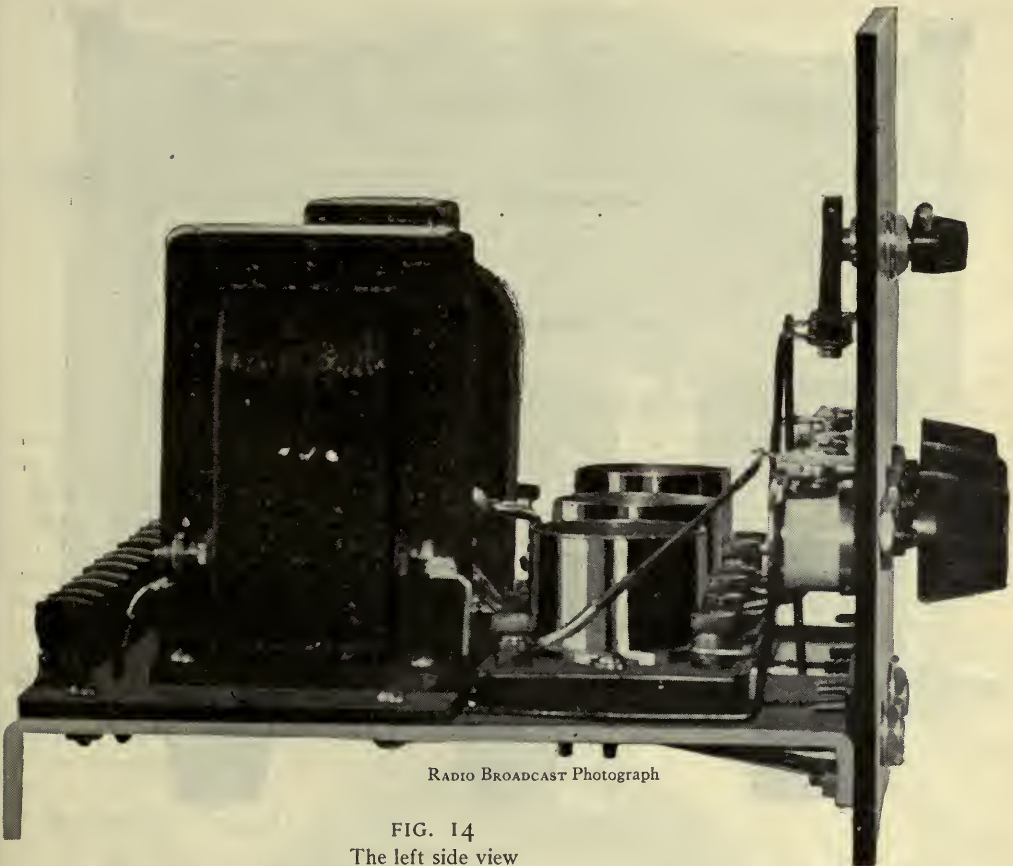
Wherever possible, lugs have been clamped down under terminal nuts to provide an easily accessible point of soldering.

As a standard detector-two-stage audio amplifier, this unit is admirable for use around the laboratory where the experimenter is frequently trying new tuner circuits and requires a means for detecting and amplifying his received signal. Its primary purpose is for use with the two-stage radio-frequency amplifier described in the May, 1925, RADIO BROADCAST.



RADIO BROADCAST Photograph

FIG. 13
Looking at the amplifier from the right side



Radio Broadcast Photograph

FIG. 14
The left side view

The circuit diagram, Fig. 8, shows how these two units may be connected together.

Plate voltages of from 90 to 120 may be used on the two audio stages while for the detector 45 to 90 volts will be suitable. No definite voltage requirements are specified as this depends entirely upon the tubes and transformers used. Six-volt tubes will probably give greater satisfaction in this unit, although it is of course entirely possible to use one and one half and three-volt tubes.

The loud speaker may either be plugged into the last jack or the cord tips fastened in the output binding posts. The jack for the first stage is not of the conventional double-circuit type but is a single closed-circuit jack which includes the phones or loud speaker in series with the primary of the first transformer when the plug is inserted.

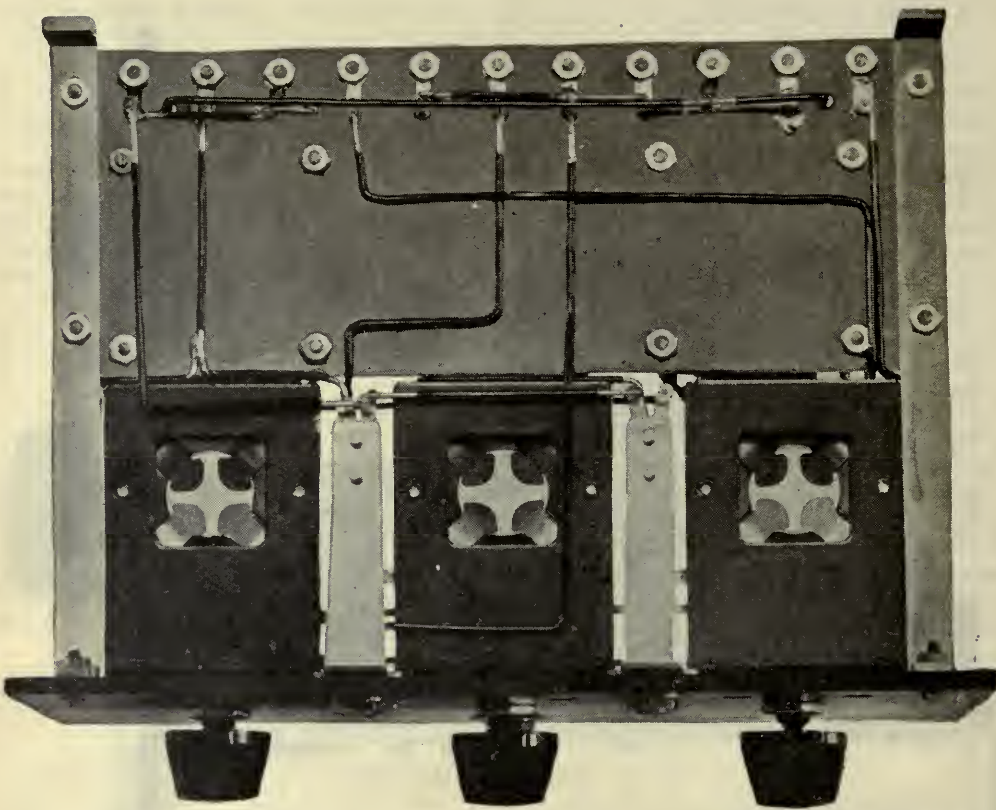
OPERATION OF THE AMPLIFIER

ONCE the unit has been adjusted for one particular time, for instance, an evening enjoyment of a radio program, there is nothing that need be touched with the possible exception of the grid leak. Tubes should be burned only as brightly as is consistent with clear and sufficient volume. To go beyond this point usually results in decidedly decreasing the life of the tube.

The batteries are connected to the binding posts of the amplifier as shown in Fig. 9. The C battery voltage will vary conversely with the B battery voltage applied and may conform with this table:

B Volts	*C Volts*
80	3.0 to 4.5
100	4.5 to 6.0
120	6.0 to 9.0
150	9.0 to 12.0

The tuner unit output is connected to the detector-amplifier input at its input binding posts. Amplifier output posts are provided which allows the use of a loud speaker without plugging into the jack. Several tuner and radio frequency circuits with which this unit might be used are shown in Fig. 10.



RADIO BROADCAST Photograph

FIG. 15

Simplicity in wiring is clearly indicated in this bottom view. It also shows the need for accuracy in layout, as there is not much room to spare for the sockets between the two brass brackets

If there is the slightest trace of a high-pitched singing noise, it is well to ground the negative side of the A battery and the cores of both audio-frequency transformers.

Where trouble is apt to be encountered, it is suggested that the constructor proceed first by re-checking the entire circuit diagram with the wired circuit of the unit. Sometimes it is possible that transformer windings are open-circuited or bypass condensers short-circuited. Be sure also that positive contact is made between the several blades of the jacks and that the filament switch is working correctly. Tube prongs may also be bent down too far, preventing the tube from making contact with the socket blades.

From the several assembly and wiring photographs it will be seen that some leads have been passed through holes drilled for the purpose in the sub-base. Many of the leads running from the sub-base assembly to the panel pass through the narrow space between the sub-base and the rear of the sockets.

When enclosed in a suitable cabinet, this detector-amplifier in appearance will grace any installation and is admirably adapted for the special requirements of the experimenter.

The Listeners' Point of View
Conducted by Kingsley Welles

Summer Radio Programs Are Attractive

WE IMAGINE that the broadcast program directors, harassed fellows that they are, breathe a sigh of relief when the summer season comes around. A glance at the daily radio programs in the newspapers, bought these steamy summer days, shows that there is plenty of interesting entertainment which can be led into the willing maw of the domestic loud speaker. At the risk of incurring the wrath of those who make what is flippantly called a livelihood from the business of transportation, we should like to suggest that the faithful radio set can provide entertainment and amusement in the coolness of one's home which make a trip to the scene of the festivities entirely unnecessary.

Although the concert season has closed, and the members of orchestras which have been heard from many stations during the winter and spring with so much pleasure have scattered, there are still many excellent bands which will be on the air from various stations during the summer. The United States Marine Band is probably the best known of musical organizations of this sort that can be heard during warm weather. Every Wednesday evening from five to six thirty, Eastern Standard Time, this band can be heard through stations WRC of Washington and WJZ of New York. These late afternoon concerts will supplement the regular weekly concerts played in the Sylvan Theatre at Washington which are broadcast every Thursday night from seven thirty to nine, Eastern standard time. WEAF and eight others are broadcasting several concerts weekly of the Goldman band from the bandstand on the campus of New York University, beginning at 8:30 and concluding at 10:15 Eastern daylight saving time on the evenings concerned.

FRITZ REINER

The famous conductor of the Cincinnati Symphony Orchestra which has been heard over station WLW, of Cincinnati. Mr. Reiner, who is quoted elsewhere in this department, thinks that radio can do much to elevate American musical taste. His own activities through WLW have done a great deal toward giving broadcast listeners music of unequalled quality

WJZ, WGY, and WRC will broad-

cast three times weekly concerts of the New York Philharmonic Society. The orchestra plays in the Lewisohn Stadium, New York.

Listeners to WWJ, of Detroit, remember with much pleasure the concerts of Schmeman's Band which have been broadcast from Belle Isle park in that city. Alert program managers in many other cities promise bands of high grade.

And sporting events seem to get on the air more regularly during the warmer months, which is probably most simply explained by the fact that there is more activity of this sort at this time of year. The famous Indianapolis automobile races were broadcast from WGN at Chicago on Memorial Day with great success. College baseball games were on the air in many sections of the country in the weeks before academic doors closed for the summer holiday. WJZ handled particularly well the job of reporting a recent game between Yale and Princeton to say nothing of the Yale Commencement exercises in June.

Station WJAZ, of Chicago, is making plans to broadcast the classic Lake Michigan sailing yacht races between Chicago and Mackinac Island. A small short wave transmitter will be set up on a power boat which will follow the yachts as they speed up the lake.

It is unfortunate that one or more of the enterprising Eastern broadcasters do not arrange to broadcast more of the college crew races. WJZ made a brave stab at it not long ago when they put a short wave transmitter aboard the yacht *Elco* in the Harlem with the capable Major J. Andrew White at the microphone and broadcast the Childs' Cup race between the eights of Columbia, Pennsylvania, and Syracuse. The Poughkeepsie races in June afforded a tremendously exciting event to listeners interested in sports. Major White at the traveling WJZ microphone brought his listeners along with him by the color and imagination of his picturesque descriptions.

In the main, out-of-door broadcasting is more successful than might be thought. Reverberations present in a large hall make the problem of properly broadcasting an orchestra or band most difficult. As Mr. Carl Dreher suggests this month in "As the Broadcaster Sees It" open air broadcasting is usually quiet and free from the unpleasant effects of sound, bouncing about where it should not go. And, barring the barking of disturbed and inquisitive dogs, and the squalling of tired children, the broadcaster who sets up microphone and speech amplifier in the open air is usually quite successful.

However, a few weeks ago, WJZ was broadcasting the ceremonies incident to the unveil-

GOVERNOR NELLIE TAYLOE ROSS

Of Wyoming and Governor Clarence J. Morley of Colorado, before the microphone of KOA, at Denver. Governor Ross shares national honors with Governor "Ma" Ferguson, of Texas as the first members of their sex to guide the political destinies of an American state

MARION DAVIES
Who was heard at a "Motion Picture and Vaudeville Star's Radio Party" from station WIP, in Philadelphia

ing of a tablet to Thomas A. Edison, from Menlo Park, New Jersey. The speeches were in the open air and came through in excellent fashion. But the scene of the affair was close to the main line of a railroad, and at times during the broadcasting, the hasty puff of the engines came through the microphone with such force as to interrupt the words of the speakers. Governor Silzer, of New Jersey, who made one of the principal addresses, remarked that the occasion was probably the first time that the State of New Jersey was in direct competition with the railroads.

Many of us have felt, during the broadcasting of a prize fight, to choose a happy example, that the miscellaneous noises—the cheering of the crowd, the gongs and bellow of the announcer in the ring—are a decidedly necessary and desirable part of the affair. The commercial noises of a railroad, however,

THE SANDMAN OF STATION KHJ

At Los Angeles. Those who have that unusual ability to talk *to* children instead of *down to* them are heard from many broadcasting stations, and the "Sandman" of KHJ is one of the most able and most popular of the broadcasters of this sort

are not much of an addition to most outdoor pick-ups.

A Statement of Policy

IT IS no easy task to take up "The Listener's Point of View" where Miss Mix left it. In the fourteen months that she wrote this department, she succeeded in building up a following of readers in all parts of the country which any writer might envy. This was natural indeed, for her comments and criticism combined in delightful fashion, great breadth of knowledge of matters musical and a charming style of presentation.

The present writer, readers willing, will attempt to carry on. His design involves news and comment of broadcasting stations, artists, and broadcast programs, and all else which is of the ether etherial.

It was in February, 1924, that the editors of RADIO BROADCAST planned this department, and in the April, 1924, magazine that Miss Mix's first department appeared. A few days before the April number appeared on the news stands, the New York *Herald Tribune* began their daily broadcasting critique "Last Night on the Radio" written by the caustic Mr. Raymond Francis Yates, who used the name "Pioneer." After that, it seemed as if newspaper and magazine radio critics increased even as the beasts of the field.

There are now probably anywhere from three to five million radio receivers in this country, if one accept the most credible estimates of those arithmetical persons who interminably compile statistics on the number of radio listeners. That chip falling where it may, however, it is our hope that some of the owners of the five million receivers may find something interesting in these pages each month. That object being attained, as J. Caesar would say, we hope to read your letters of opinion and comment on broadcasting—our mutual concern.

What Makes a Broadcasting Station Popular

IN THE first exciting days of broadcasting, the very act of receiving the sounds of tinny phonograph records and the noisome regularities of a mechanical piano was regarded by the wondering public as a stunt, a kind of theatrical laboratory experiment. And many of our broadcast directors have never allowed that feeling to weaken in the minds of what they are pleased to call their clientele. While listeners are able to depend on this station and that for regular features of one sort or another, they look to others to supply them with something new, curious, *outré*.

Witness the Philadelphia broadcaster who sent a studio favorite in a diving suit to the bottom of the ocean near Atlantic City, where for some fifteen minutes he regaled his listeners with sub-aqueous, non-scientific platitudes. A year ago, much journalistic to-do was excited over the broadcasting of the sounds of the circus. And so we have had various attempts at broadcasting from an airplane, none of them especially successful.

The learned Secretary Wilbur arranged with his Naval radio and publicity experts to install a low powered broadcasting set on the *Los Angeles* when she made a recent all-day voyage over Philadelphia, laden with a cargo of merchants. Gar Wood's "race" between one of his speed boats and the Twentieth

Century Limited was reported by radio from an airplane flying over the racers on their two hour trip down the Hudson from Albany to New York. One hesitates to conjecture what the next stunt will be. In some respects our English friends are not far behind; was not the song of the nightingale broadcast from 2LO to the tune of newspaper space, measurable only in feet?

The directors of broadcasting stations will admit, almost to a man, that they are, after four years, still experimenting. They are not yet really certain what the public wants. But we are certain that the public is primarily interested in the best. If a broadcasting station has gained a reputation for excellent classical music or for jazz music of good quality, or for good lectures and speeches, or whatnot, that station can be best kept in the favor of the public by a continuance of the policy. We doubt very much that temporary bursts of publicity, gained from the studio presence of movie stars who tell radio listeners of their innermost thoughts, or by the broadcasting of a jazz melange from a steamship at dock can do much permanently to gain public favor. The station which daily meets the real wishes of its listeners is the one whose popularity will last.

An Orchestra Conductor Speaks About Radio

THE greatest hope for radio is that it may bring good music to all parts of this vast country, and awaken in the soul of America a thirst for the best in music. Radio should teach the people to learn to love good music. There can be no cultural progress so long as people are given only what they already enjoy. Let us teach the people to want something which has not yet been given them.

"For the most part, radio is considered by everyone as merely a medium of entertainment. And this entertainment is almost entirely music. This is a desecration. Music

MAY SINGHI BREEN AND PETER DE ROSE

Who have been heard from station WEAF and others in banjo and piano duets. Miss Breen is a banjo player of striking talent and is well known to radio audiences. The insert shows the head of a banjo she has used in many radio studios with its signatures of radio favorites, including Jack Yellen, Doctor "Billy" Axt, and George Gershwin

should be a divine service to humanity. It is a pleasant thing when enjoyed as a mere pastime. But with every mental uplift, there must be a consequent struggle, and in order to comprehend the divine beauty of music, one must be willing to make the sacrifice of laboring to understand.

"One of the beautiful possibilities of radio, as I see it," continues Mr. Fritz Reiner, conductor of the Cincinnati Symphony Orchestra, "is to teach the fundamentals of music to the people. Americans have plenty of sentiment; they are not cold blooded. Their only drawback is that they do not know how to express themselves. Teach them the fundamentals of music and the genuis of the nation will assert itself. When the whole nation loves good music it will pay for good music and thus afford an incentive to its youth of talent and intelligence."

Mr. Fred Smith, director of station WLW gathered these interesting ideas from Mr. Reiner, who is accepted as one of the outstanding symphony conductors now in America. WLW has done much in furnishing good music to its listeners. When the new long range station of WLW was opened, Mr. Reiner had charge of the dedication program, when he conducted a special concert with an orchestra of fifty picked men from the Cincinnati Orchestra, At other times, his Orchestra has been heard from WLW.

Other stations are known for the good music on their programs. Station KSD of St. Louis has the record of broadcasting every symphony concert of the St. Louis Symphony during the past season. The Detroit *News* orchestra, a permanent part of the studio staff of station WWJ, is composed of members of the talented Detroit Symphony Orchestra. Station WEAF, of New York has broadcast regularly the concerts of the New York Philharmonic Orchestra. The good music that Mr. Reiner hopes American listeners can hear is being sent out from various parts of the country, though it has to force its way through a blanket of jazz. It is the contention of many that enough good radio music is being played now so that the taste of American listeners is slowly being raised. More will be said of this later, however.

Broadcasting, Canadian Style

IT IS bad enough," someone remarked, with what was probably a vocal twinkle, "when one listens to a Floridan or a Californian sing the praises of his climate to a small group, but when they buy radio stations and, in a manner of speaking, tell the world about it, the situation becomes serious." Good residents of Florida and good residents of California *have* bought broadcasting stations, but it must be recorded that they are reasonably restrained about the climatic merits of their communities.

But now are the Canadians fallen from virtue. CKAC, the excellent station of *La Presse* at Montreal, cannot withold the attractions of the Province from a listening world. On their program for the two weeks beginning May 30th, appeared the following legends.

June 2: 8:30 P. M. Talk on Attractions of Province of Quebec
June 6: 8:30 P. M. Road reports; talk on the attractions of the Province of Quebec
June 9: 8:30 P. M. Talks on the attractions of the Province of Quebec. Road conditions reports
June 13: 8:30 P. M. Studio program; talk on Quebec attraction.

Sir Robert Falconer, President of the University of Toronto, has been giving a series of lectures before English Universities on the general subject of Canadian and American relations. One of the interesting points that he made was that Canada and the United States were closer in some respects than England and Canada. This is due, Sir Robert thinks, to the fact that Canadians read American magazines and hear American broadcast programs, both prepared for purely American consumption. A Rotary Club speech from some Middle West city is heard by a group of far-off ranchers in distant Canada. So, thinks Sir Robert, do American ideas penetrate Canada.

But now the American leaven is working, and listeners on this side of the border are getting some of their own medicine. A new and amusing form of reciprocity!

General Dawes as a Musician

SINCE Charles G. Dawes, Chicago banker, attained world wide, and later national fame through his feats of statesmanship and politics, broadcast directors have discovered that this picturesque and extraordinary person is a composer of parts. Several of his compositions including his "Melody in A Major" have been heard by radio listeners. Which calls to mind the Washington experience of Mr. Heywood Broun, the genial columnist of the New York *World* who inquired of a politically in-

clined woman of his acquaintance how the General ranked among composers.

"Does he write good music?" asked Mr. Broun.

"That all depends," the lady answered, "on whether you are for or against changing the rules of the Senate."

When Central Americans Overhear the United States

AMERICAN broadcasting stations are picked up throughout all the Central American republics, and programs are enjoyed as a rule, though there has been some complaint regarding the quality of music," reports R. A. Lundquist, chief of the electrical equipment division of the Bureau of Foreign and Domestic Commerce at Washington, after a recent trip through that territory.

"On the other hand, in several cases, radio fans who had instruments of sufficient selectivity and range to choose between American stations, commented favorably on this point, saying that they were surprised to note the quality of music received from small towns where the programs were given by local talent. This was especially true of the Middle Western states which are apparently in some sections picked up more readily than are those in the East or far West."

Those who use care in tuning and pick up some of the smaller mid-West stations will hear good music, well played. In these localities, there are numberless amateurs of the voice, piano, and violin, whose names never appear on great concert programs, who are heard over the radio from stations the length and breadth of the country.

TEN EYCK CLAY

The new director of the WGY Players. Station WGY was the pioneer in securing and presenting radio plays and has found that radio listeners favor short plays, prepared especially for broadcasting

"We have used the home type of music and program at our station," said Mr. Henry Field, of Shenandoah Iowa, owner of station KFNF, "partly because it was the easiest thing for us to do, and partly because I had the definite opinion that people were hungry for the home type of music. We feel that there is a big demand, which many people do not suspect, for simple, wholesome, old-fashioned music. I find that a surprisingly large number of listeners of all classes are very tired of cabaret music and would like to have more of the old home-town stuff." Mr. Field was addressing one of the committees at Secretary Hoover's annual radio conference at Washington, last October. He continued, "I have a letter in my pocket from a prominent man here in Washington who listens-in regularly. Both he and his wife are small town people. It would be interesting to hear their comments on the cabaret type of music which they get from so many stations, and how "it seemed like a breath of air from the prairies" to hear Gospel hymns over the radio."

Fewer jazz orchestras and a bit more of what may be called standard music from broadcast stations would meet with great favor from the public, if existing signs may be taken as any criterion.

Broadcast Miscellany

ONE of the two women governors in the United States was heard over the radio from station KOA, Denver, some weeks ago. She spoke on "Cheyenne Frontier Days and Wyoming of To-day." Listeners were much interested in her description of the change in her native state.

"SIGNING off," that phrase heard from every broadcaster at least once during the day's program, is to be abolished at station WLW. Some "appropriate quotation" will be given instead, and finality achieved by "Good night." The news bureau of WLW offers as a sample quotation: "Great thoughts, like little deeds need no trumpet; good night." "Signing off" is a hold-over phrase from the telegraph side of radio, and, like the use of call letters to designate stations, has little to do with broadcasting. We think this is a step in the right direction, but why complicate the closing with a sententious quotation? Isn't a simple "Good night" enough?

LISTENERS are constantly on the search for an up-to-date list of broadcasting stations, their wavelengths, power, and call signals. One of the best of the many books we have seen is *Dunlap's Radio Call Book.* In addition to listing all the radio broadcasting stations of the world, the book contains their slogans, and is kept up to date by a monthly supplement containing changes and corrections. It may be secured for $1 from Dunlap's Radio Call Book Service, Box 88, Flushing, New York.

CORRESPONDENCE from controversial-minded readers of this department is invited. We are anxious to present the opinions of readers on broadcasting and its problems, and it is our hope that this department will be considered a forum, open to any one who has something to say and says it with clarity and intelligence. Correspondents are asked to do us the courtesy of signing their full name and address, which will not be used if if they so request.

THE MECHANICS OF A RADIO PLAY

In operation at WGY, when the WGY Players put on "Rip Van Winkle." Ten Eyck Clay, director and leading man of the Players is at the microphone as Rip. Frank Oliver is pouring water through a sieve to give the effect of rain. In the background are the thunder sheet and the wind machine. The radio Players seem to be enjoying their share of the performance as much as the listeners, which is putting it mildly

The Revolution in the Art of Teaching

The Long Arm of Radio Is Bringing the Best from the College to the Remotest Districts—What the Public Wants and How Their Wants Are Being Met

BY FREDERICK P. MAYER

THE long trips on cold trains in winter, the meals in poor restaurants, the leaving of work and papers to do what seemed of doubtful permanency are things that only the professor who used to give lectures to small groups in various communities can understand.

The university extension course was given in the high school auditorium of some small town where there were enough high school and grade school teachers and enough interested club women to make an audience of perhaps a hundred. To this small group, the university sent out, at a heavy financial outlay, a part-time "extra-mural" teacher who traveled to the small town from his school, delivered his lecture to the one hundred teachers, and went home again—with little done for the outer world of popular education and little done for himself and his school.

But radio is changing all this. The professor of to-day prepares his lecture for his radio class with greater care than he gives to the class lecture on the campus. His audience may include professors in his own field who are eager to check the work his school is doing; he knows that business men and high school boys, men in barber shops and clubs are his class.

Giving the Teacher the Air

IS ANOTHER experiment with the possibilities of radio. Mr. Mayer does not attempt to tell what every university and college in the country has tried to do with broadcasting, but he does tell what has been in progress at Pittsburgh. Columbia, Rennselear Polytechnic, New York University, Kansas State Agricultural College, and many others for some time have been broadcasting subjects gathered from their class rooms. And many broadcasters have presented talks given by members of various college faculties. There are many who feel that radio can never lend the personal contact that the University has always felt to be a necessity for instruction. But there are others who are quite willing to let radio do what it can to broaden the scope of higher education, and some of the experiments seem to prove that radio has indeed a field here. It is maintained by some that broadcasting is more a medium for entertainment than instruction, but those who are in charge of the various "air courses" undoubtedly have something to say about that. In an early number, RADIO BROADCAST will publish an article by Major J. Andrew White, the famous descriptive broadcaster, which humorously shows that radio education is—well, not as effective as it might be.—THE EDITOR

Having prepared his lecture, he goes to the broadcasting studio, that curious muffled room where his voice frightens him by meeting him as he walks in. The room is draped with gray cloth, and there are wicker chairs, a desk, and floor lamps. And reasonably inconspicuous, are the ever-faithful microphones, from which you hear the lecture on "Why Read Fiction?" or "Political Parties from Washington to Jackson," listeners-in from Florida to Washington, and throughout Canada eagerly tune-in.

The light flashes; the man at the announcer's desk calls "all right" to his friends at the broadcasting station; they return the signal; he flashes the "Silence" sign at the desk, and opens the line. The air is ready. The instructor begins after the University announcer says, "Good evening! This is the University of Pittsburgh studio of station KDKA, East Pittsburgh, Pennsylvania. This evening, Professor Smith, of the English Department is going to talk to you about 'The Contemporary Novel.'" Then a slight pause, and the Professor begins his talk. This is what has been occurring regularly at KDKA in coöperation with the University of Pittsburgh, and is true of other broadcasting stations in many parts

of the nation. Some universities have erected their own broadcasting stations to give "air college courses." Notable among the colleges to try this experiment in education is the Kansas State Agricultural College whose call, KSAC is known to many.

At Pittsburgh, extensive plans have been made for bringing the learning of the college class room to the radio listener. A year, or more ago, the University of Pittsburgh, through its committee on radio extension, discussed ways and means of beginning radio extension through its own studio. Conferences resulted in an agreement of mutual responsibility for the new venture. The University agreed to furnish the studio and to appoint a full time radio manager whose business it would be to arrange programs of consistently high merit. The Broadcaster installed transmitting apparatus which cost several thousand dollars.

The opening night was an important event for the radio world. There had, of course, been university studios in operation before KDKA and "Pitt" began, but none had consistently pledged themselves to serious extension work. University and commercial studios had, before this, differed little in aims.

The program opened with University songs by a University quartet. Then Mr. H. P. Davis, vice president of the Westinghouse Company, delivered the first address, and turned the studio over to the University for its use as an added means of bringing knowledge and new ideas to the people it hoped to serve. Dr. John G. Bowman, Chancellor of the University, followed Mr. Davis with a brief talk of acceptance, and outlined the plans and aims of the program of popular education. Mr. Marcus Aaron, President of the Board of Education of Pittsburgh, then told how the people in Pittsburgh had a new means of education advancement put into their hands. At the close of the evening, the University was launched upon its experiment, with Miss Helen J. Ostrander, manager, in charge of programs and speakers.

THE FIRST YEAR

THAT year was a busy one for the new studio. Two ten-week courses, one on literature, by members of the English Department, and one on party government, by members of the History, and the Political Science Departments, were broadcast on successive Mondays and Tuesdays. During the first month of lectures a very encouraging number of appreciative letters were received by the University, and so the University added extra lectures by members of its staff.

There were talks about trees and wild flowers, weeds, birds, fish, and the stars. It was amazing to see how great a demand for nature talks there was in the industrial radius of Pittsburgh, a section that is normally listed as interested only in steel affairs and the making of rails. Not only boy scouts, but also men and women wanted to know more about plant and animal life and the wider world round about. Broadcasting educational talks, the University believes, is one form of radio work that can be made to have genuine value as a means of getting popular education to more people. The days of the educational phonograph record, the correspondence courses, and the extension courses are threatened by the new method of giving course instruction to thousands who want it and find it hard to get. The demand for outside readings and questions for study and printed forms of the lectures made it necessary to print radio publications which were distributed at small cost to listeners all over the country, who gave some of their winter

The Future of Radio Education

WHEN radio has settled down to a constructive basis, instead of being, as now, chiefly a medium for light entertainment, educational courses will take on a more important aspect. No doubt, broadcast directors would hesitate to put on a musical lecture that lasted more than an hour. They would see, in their imagination, thousands of impatient listeners, tuning-out to a more congenial attraction. Yet, they might use their imaginations to realize that those who interest themselves in these education courses would be more numerous if they thought that the paying of a fee of one dollar, for example, for literature and examination papers would include an hour's instruction weekly.

Perhaps, in time, we shall have certain broadcasting stations given over wholly to educational programs. If this day comes—and such a thing is not unlikely—a course in musical appreciation, in literature, or any of the other educational subjects now put on the air will be more thorough than is at present possible."—JENNIE IRENE MIX, *in "The Listener's Point of View,"* RADIO BROADCAST *for February, 1925.*

nights to pleasant reading under the direction of a university faculty hundreds of miles away.

THE POSSIBLE AND THE IMPOSSIBLE

THE universities which are experimenting with radio as a means of instruction do so with no illusions. The standard of the work done, the knowledge of the student's abilities, the supervision of study that a campus course or an old extension course can give is indispensable for serious study of a high academic rate. It is manifestly impossible to give university credit for radio study. As yet, no means has been found to check up on work done by radio students. A radio course can never take the place of a college year spent on the campus.

Universities that are giving radio courses seem to believe that they can give the means for individual self culture to people who are interested in having new ideas, no matter where they live. There are men and women so far from the contact of intellectual forces and the opportunities of libraries and lectures, that new facts, new thoughts about their world and the things that are going on in politics, and letters and science, cannot help but be a means towards happier living in an isolated area. The radio can inspire the same interest in social and political progress that a good magazine, clearly written, can give. Indeed, the radio can do more. It gives the same material as the magazine does, but it gives it in a more immediate form. It is easier to listen to a man speaking than to go

BROADCASTING HEADQUARTERS OF THE UNIVERSITY
And Miss Mary F. Philput, radio manager for the University of Pittsburgh

to his book, provided that he speaks clearly, slowly, and with a sense of real interest in his subject. That is what the men at the University have had to discover. They must talk with more energy to a class that they cannot see than to one that is in the room with them, because the voice is their only chance of appeal. What applause is to a vaudeville rope climber, the presence of a flesh and blood class is to the teacher. He needs applause, and he has to fight the blankness of the microphone while he delivers his radio lecture. It is amusing to see a teacher stand before a microphone and wave his arms with his usual class-room gestures and find that they mean nothing to the silent microphone or to the man on the North Dakota farm who is wondering "why doesn't that chap talk so I can hear."

Is radio instruction reaching an audience that wants such help? As an answer to this important question, the University could look only to whatever letters came in. But would anybody care enough about political parties and the contemporary novel to write even a post-card! And if they heard the talks, would they like them? The answer came almost immediately. The files of the radio room are stuffed with letters from listeners from Canada and thirty states, including Nebraska in the West, Minnesota in the North, Louisiana in the South, and every state on the Atlantic coast. Among the writers are lawyers, dentists, physicians, bankers, business men and women, high school students, farm men and women, teachers, housewives, college students, club-women, and grade school children.

Of course, there were complaints. The University expected them, more than came in. But not one letter of objection to the idea as a whole appeared. All the writers liked to listen to the talks, but they objected to big and little things in the way the talks were given—and mostly with justification. One man objected to the pronunciation of the word "vaudeville," and he was right. One man said the speaker talked too fast; he had sat by his typewriter and tried to take down the names of books to read, and the speaker rushed through them without a chance for a note. The lecturer of that night, who was accustomed to dumping masses of material on college classes who could go to a library later, spoke more slowly on the following nights. Another writer asked if we wanted any one to hear what we were saying. If we did, would we talk louder? And we did. Several women who were normal school graduates and wanted college work insisted on getting credit for the lectures; they asked for examinations and papers to be graded. That request, much as the University wished to help, was refused.

WHAT THE PEOPLE SAID

APPRECIATION for the new thing came in all forms, from the serious to the funny. The people who wrote ranged from men and women with college degrees to farmers who had little advanced schooling, and yet thought it was worth their while to say that they liked the programs. Stationery ran from beautiful sheets of embossed personal writing paper and bond sheets of discreet banking houses to the printed splash of an Iowa seed store, and the pencilled scratchings of an old man who found the "radio was something to look forward to once a week."

A letter came from a friend of a young man sick with tuberculosis. He asked for a reading list that might "be of some benefit." The boy wanted "in that way to educate himself as much as possible from this source." Needless to say, the English department got busy. A group of students from Wittenberg College were gracious enough to want the lecturer to know that they were taking a course in the novel with him. A club woman from South Carolina found that the lectures helped her in preparing a program on the contemporary novel. A woman on a New Hampshire farm, who had taken a course in the novel with Katherine Lee Bates in her college days, said "I now live on a remote farm, and I am especially pleased with your proposed course, What that means in terms of days on a farm. no mere city reader can quite understand."

A mother wrote for the novel bibliography. "We are desirous of putting the best of reading matter before our four children."

A man from Philadelphia wrote to the University and asked for an outline of the lecture, because he missed part when his daughter ran a splinter into her finger, and he had to leave the phones and help. Unfortunately he did not give his address. A directory searcher gave us his address, and the following letter is the result of this correspondence.

> Did I hear the announcer say to send 10 cents for the program? My daughter run a splinter in her finger so Dad missed part of the broadcasting. I had to get that splinter out. Well I am one of KDKA listeners in and must say I am very much interested in education and if nothing prevents me I will be a regular listener. In Phila. we have a lot

of single circuits so we who are anxious to learn will have to make the best of it. Well Mr. Manager it is well worth trying for. When you go fishing some get little ones others get big ones so I hope I will be be able to get all that is possible out of your generosity.

That is the sort of friendship the University of Pittsburgh feels glad to have made; it is worth much to the people who are wondering whether or not radio pays.

A gentleman from Pittsburgh wrote,

I am an invalid who is *getting well.* I have had a wonderful sense of help by radio in listening to the good sermons, prayers, and lectures. I have been ill many years and have spent many years in bed with too much weakness to even listen-in. Radio opens a glorious avenue to me. I love the fairy stories for children and the bed time talks. . . . Now I see that light and health are coming. This beautiful spring day—all Nature simply singing—I had to write you this personal side of things, it seemed. Pardon me, but you will be glad to know it. You asked so kindly what we would enjoy. I would enjoy bird lore and nature talks, *woods* and out-doors. It is so lovely to hear word pictures over the radio. I imagine I am living it. One enters with much more intimacy into the mind of the speaker when there is nothing to divert. I enjoy the literature professors. . . . I enjoy your voice *so* much.

DR. JOHN G. BOWMAN
Chancellor, the University of Pittsburgh. Radio college courses have been tried under his direction and are meeting with a favorable reception according to statements of the University authorities

And this is another of the letters the university studio is happy to have on file.

WHAT THE PEOPLE WANT

AMONG the courses asked for by listeners were lectures on ancient and medieval and modern history, biology, banking, advertising, and salesmanship, musical appreciation, and history. Radio teaching will mean a busy life for the University if it tries to meet suggested demands.

An alumna in New York felt that she was back on the campus again when she heard the English lectures, and asked for a series on Child Psychology. "Of course, I realize that any work of this kind must, of necessity, be very superficial but it certainly has some value dependent largely upon the amount of supplementary work that is done in connection with it."

So the letters came in. Each mail brought new acquaintances from new places. The first year of University Extension by radio was a successful experiment. It is, as yet, only an experiment. What science can do to make radio reception easier and more certain, what the University can do to give more and better lectures, what the listener-in can do in the way of preparation for what he reads, make the trio of factors upon which success in popular education depends.

Some people—as the hundreds of letters show—are getting pleasure and profit from the work. But can it hold its own place, this educational program, in the face of dance music and comedians? Or is the percentage of fans who do not want this, large enough to make the radio broadcasting companies reject educational features because they are unpopular with a majority? Only time will tell.

The best letter of appreciation for serious programs came to the broadcasters from the pastor of the Point Breeze Church, to whom the following letter of thanks was addressed.

Monday

To the Minister of the POINT FREE PRESBYTERIAN CHURCH
PITTSBURGH, PA.

DEAR SIR:

Last night while making for port off the Montauk Point Light, I was listening in on my radio which I installed on the last trip to the States, and the first which came in was the music and then the rest of the service at your church. I write this to you for the purpose of calling your attention to what I call a study mixed mentality. When I got the music

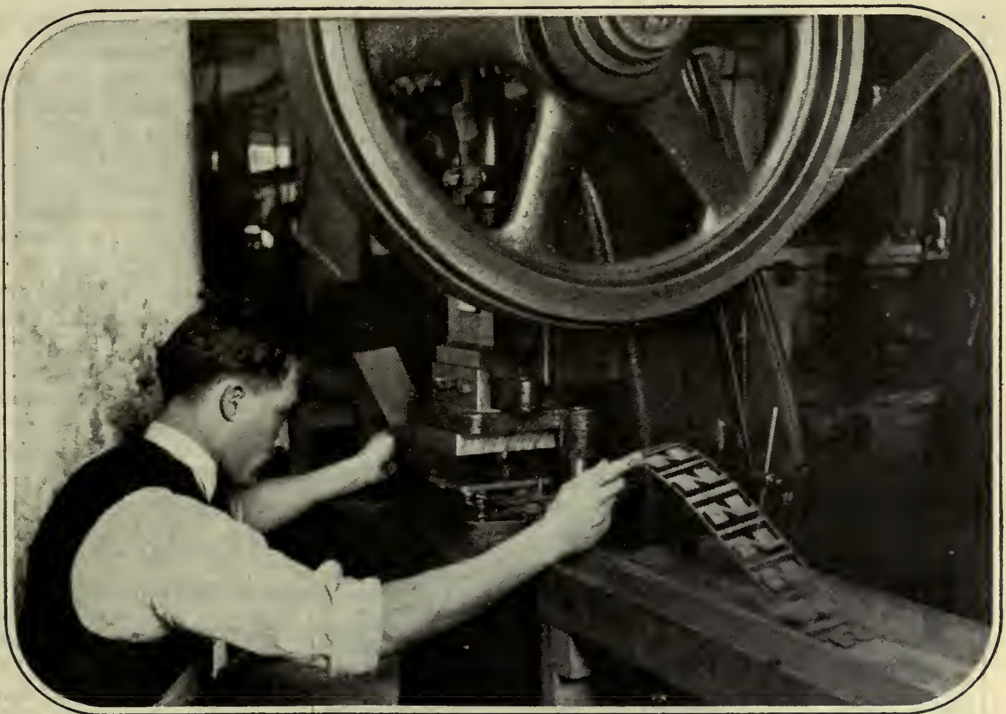
the deck hands as well as the dog watch was in the Cabin all hoping that the "Darnation thing would work" and when I said I had a church service on the air they all gave a great guffaw and laughed heartily. After a time the grins, and horse jokes laid off, and the faces of the swabs all took on a serious look and after a time, I said well I guess thats enough of that stuff, and much to my surprise, every damn one of them roared out, No leave it alone and lets hear what that stuff is all about. I held the service all the way to the finish and the trouth is that they all was pleased when they had the whole of it as they said it was the first time they ever had anything of that kind served to them, except when I read the service for the dead at sea, and they all admit I aint great shakes at that. Had two to slide over the side on the last trip. The mast hands told me to get in on it next Sunday, but since we clear for South Africa Friday, I am afraid we will be out of range, but at that we will be listening in and if you are on the air we will get it from Hell to Breakefast. The funny thing and the thing that struck me as so queer is that most of the square heads that I have aboard hasnt been inside a church since they was born, and now damned if they aint talking about the church they heard on the radio while they are unloading cargo, and I can hear 'em through the port. Next Sunday talk strong, and slip over something about sailors, and I believe you will be making church goers of a lot of swabs that aint much good and never will be. Muck oblidged for your music and preackin Sunday, and say I want to tell you you have some singers, and especially the first saprano who was nearest the speaking makine her voice come over like a bell. Heres hoping we can get you all the way cross, and more power to you for your favor. Excuse me taking the liberty of shooting all this off to you but I thought as how you might like to know what kind of a lot know nothings at least some of them you have for your services.

Yours truly
(*Signed*) John Clapman
Master
Barkentine *Plymouth*
Registered Lloyds
London

P. S. Your preaching is good Its the first I heard in eighteen years and I enjoyed it.

AIRPLANE VIEW OF THE CAMPUS, UNIVERSITY OF PITTSBURGH

The large open square with the tennis courts, lower right, is the fourteen-acre plot which is the site of the new University of Pittsburgh "Cathedral of Learning," a fifty-two story Gothic building. Plans are already under way for this structure. The radio studio of the University is located in a room in one of the smaller buildings near the center of the campus. It is connected by wire to the broadcasting station



STAMPING OUT THE STEEL LAMINATIONS
For audio-frequency transformers. Transformers, like all other radio parts, are made in very large quantities and special machines have been built for their manufacture

THE MARCH OF RADIO

By J. H. Morecroft
Past President, Institute of Radio Engineers

Why the Radio Industry Will Not Be Revolutionized

ONE of the prominent radio manufacturers recently expressed his opinion of the phrase, "revolutionizing the radio industry, "coined by some business man with the idea of preparing the public to buy the set he had in process of manufacture. The term has been used by many radio publicity writers. They undoubtedly think that their use of the expression would make their task easier by giving to the buying public the idea that everything so far accomplished in radio development was to be scrapped in favor of some wonderful device which they alone could produce.

"The well meaning chap who coined that infernal expression" says Edward Jewett, of Detroit, "did radio an ill turn. It has raised false expectations and has cut the radio season short by about three months. Two years ago the peak of the radio season was in April, a year ago it was in February, and this last year it came around the Christmas holidays."

In Mr. Jewett's opinion, "the principal

INSTALLING A NEW ANTENNA FOR STATION WCG

The New York coastal radio telegraph station of the Independent Wireless Telegraph Company. Many ships in the transatlantic and coastwise service communicate with this station, sending and receiving weather information and commercial messages. This station has a power of $3\frac{1}{2}$ kw. and will use wavelengths of 600, 706, and 2100 to 2400 meters

contributing cause was the wide circulation of the expression 'revolutionizing the radio industry.' When people heard it they immediately hesitated, as much as if to say 'If such wonderful things are going to happen, we'd better wait a while.' Most of them are still waiting and if they are going to wait until the industry is revolutionized, they will be waiting forever."

This opinion is a sound one and unquestionably founded on fact. A great many people actually have the idea that to-morrow a new set is to be put out which will eclipse anything at present on the market, and that the purchase of radio equipment obtainable to-day is a waste of money. So undoubtedly the apt phrase has boomeranged on the industry and made inactive a large part of the prospective purchasers of radio equipment.

To one who has even casually looked over the development of radio during the past twenty-five years the idea of a revolutionary step is hard to grasp. There has never been any such step in so far as the technical progress is concerned. The Fleming valve, De Forest audion, and the concept of amplification and regeneration were all old in the art before the present radio public existed. And each of these came into being rather quietly; wonderful as they were, they inspired only moderate enthusiasm because those who appreciated their significance and value were so few. The super-heterodyne, conceived by Armstrong while working for the Government on radio development, and the neutralized amplifying receiver, first thought out by Hazeltine, Rice, and others, were both finished before the era of broadcasting even began.

If we look then for an epoch-making radio development during the past five years, the life of radio broadcasting, we really find none. Improvements there certainly have been, both in parts and sets, but nothing which has "revolutionized" the industry. The thoriated vacuum tube filament was a great advance over the pure tungsten filaments, which had been generally used in radio tubes, but even thoriated tungsten is not really a revolutionary step over the oxide-coated filament, itself older than the radio industry.

Probably the greatest recent advance in radio has been in the loud speaker and we all know that this development has been gradual enough; it has been evolution rather than revolution. A few scientists have, on occasion, been willing to announce to the press that they had conquered static, but even these venturesome ones are gradually retiring from the stage and by their silence rather

conceding that even static is to be conquered by diligence and well conceived steps rather than by any spectacular invention.

If one wants a radio set he should go and buy one now. The heralded revolution in the radio industry probably will not materialize.

What is the Radio Receiver of To-morrow?

NO GREAT single step in radio progress is likely to be made in the near future. But to counteract the impression that radio is stagnant, let us look at to-morrow's radio receiver to see what we shall be buying a year from now.

The one respect in which the set of the future will outrank that of to-day is in quality of reproduction. At the transmitting stations, hundreds of thousands of dollars are being spent in improving the quality of the radio signal emitted. Scores of the very best radio engineers in the world are analyzing each minute step from the voice to the antenna, taking pictures of the currents in the various circuits and comparing them with theoretically correct forms. Exact knowledge is possible in this end of the radio channel because of the money and talent at work on the problems.

Has the reproduction of sound in the home, from the radio signal sent out by these high

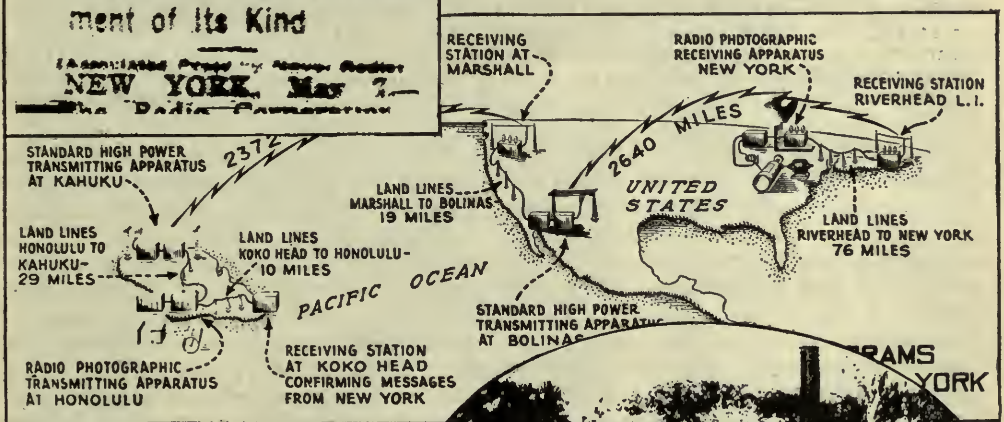
TERRITORY OF HAW

PHOTOS SENT BY RADIO HERE TO NEW YORK

Radio Corporation and Army Send Pictures Over Land, Sea, Successfully

Greatest Distance Ever Spanned: First Achievement of Its Kind

NEW YORK, May 7.—



PHOTOGRAPHS BY RADIO FROM HAWAII TO NEW YORK

The map shows the number of electrical transfers the original photograph sent from the Radio Corporation high power telegraph transmitter at Kahuku, Hawaii had to undergo before it reached New York. The insert above shows how a photograph of a section of an Hawaiian newspaper looked after being flashed through the ether to New York. The lower insert is a radio-transmitted photograph of soldiers on Hawaiian duty at mess. At the time this experiment occurred, May 7, 1925, the Army-Navy "war game" was in progress, and an excellent opportunity was afforded for showing the value of that unusual kind of radio communication

WHEN WJZ WAS PORTABLE

The short wave transmitter aboard the yacht *Elco* which was used as floating broadcasting headquarters to report the Childs cup rowing races between Columbia, Princeton, and the University of Pennsylvania. A similar arrangement was used to broadcast the rowing races at the Poughkeepsie Regatta, late in June. A receiver on shore picked up the short wave signals of the station, announced by Major J. Andrew White (at the microphone in this photograph) and thence they were relayed by wire to the main WJZ station

priced transmitters, kept pace with their development? Certainly not, and here is the place where progress, is to be expected. Ask any one with a musical ear if a radio orchestral rendition is as pleasing as the original and the answer must now be in the negative. The response of the average loud speaker and amplifying set is woefully lacking in faithfulness of reproduction. Few radio listeners turn around in surprise to find that their friend, who is talking over the radio, is not in the room with them—that a loud speaker is sending out (or trying to send out) the well known voice. And until such surprises exist we can surely say that here radio is to be improved. We do feel that great progress has been made, but still more remains to be accomplished.

In spite of the slowness of its appearance we believe that the completely batteryless set is sure to appear. It is reasonably close to accomplishment for all except the "distance hound," who may be bothered by the slight hum which may exist sometimes in these sets.

Improvement in quality of reproduction, besides keeping the loud-speaker manufacturer busy, entails on the set manufacturer a burden which he has not so far assumed. To get good quality, we must use in our sets at least one tube of much greater output capacity than the present receiver tubes possess. A small-power tube of from five to ten watts rating, must be put into the set to operate the loud speaker if the great variation in power of the voice or orchestra is to be truthfully followed. To operate such a power tube, several watts will be required for the filament, and the plate supply must be of a much higher voltage than can be efficiently obtained from batteries. This development, sure to come, will hasten the time when the lighting company's power is used completely for the receiving set.

For some time there will be many cases, of course, where batteries must continue to be of service; there are millions of homes in America which are not electrically equipped. This radio change from battery to house wires will also be gradual, not revolutionary.

The day of the nine-dial set (of which one of our friends boasted some time ago) is assuredly doomed. Much has been written about the one-dial set. Possibly with refinement in mechanical design and manufacture, it will be made sufficiently efficient to create a market for itself. It is much easier however, to make a two-dial set operate efficiently than a one-dial and as we have two hands which permit simultaneous adjustment of two dials, two controls seems reasonable and justified. The average listener probably prefers two dials to one. With two dials, the adjustment is easy enough, and with one the three-year-old child could adjust the radio outfit as well as Father. Such a situation will probably not be encouraged by the older member of the family—he would lose too much prestige.

The purchaser, who acquires to-morrow's set will probably acquire an outfit with this gradually improved quality of reproduction, greater freedom from battery trouble and easier adjustment. Improvements in the set's appearance, necessarily costly, will come as the buying public shows its preference for the art type of receiver.

The Radio Receiver of the Victor Company

THE Victor Talking Machine Company has finally entered the radio field. Said a representative of the company:

We have been urged by every known means to manufacture a set of our own. There are many reasons why we should not do so. First, the men and women who work in our factory are skilled in the delicate assembling required in the manufacture of talking machines. It would take a long time for them to develop similar efficiency in the assembling of radio equipment, a process which would be profitable neither to us nor to the public.

THE RADIO ROOM ON A GREAT LAKES PASSENGER SHIP

Radio is being modernized on the Great Lakes and tube transmitters and receivers installed. This is a corner of the radio cabin on the S. S. *Greater Detroit* which sails nightly between Buffalo and Detroit. This new liner of the inland sea is more than 500 feet long and has a passenger capacity of more than 1500. Traffic on the Great Lakes is growing heavier each year, both as regards number of ships and radio communication.

The Victor Company has completed an arrangement with the Radio Corporation of America to have super-heterodyne sets built for their talking machines. The engineers of the Victor Company decided to use this set, it was announced, after trying all the other sets on the market. A design of loud speaker new to this country is to be incorporated and it seems that this set, to appear in the fall, should prove most acceptable to the buying public.

Having thus allied itself to a certain extent with the Radio Corporation, the thought naturally arises: Will Victor artists broadcast next winter through Radio Corporation stations or through American Telephone and Telegraph Company stations? The concerts by the Victor artists were the bright spots in last winter's radio programs and everyone wants them continued, on the old lines if possible. When questioned regarding next winter's broadcasting the company's representative said:

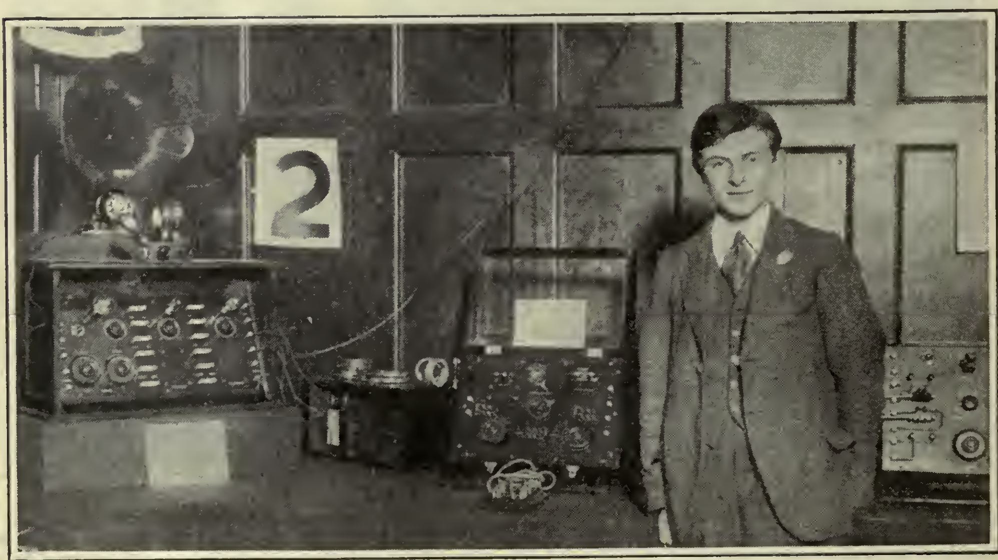
> Yes, the Victor Company expects to broadcast. It is neither our intention nor our wish to withhold great voices or great artists from the air. This phase of the situation, though, is not without its difficulties. A first requisite is that the artists be willing to coöperate and to coöperate at such compensation as may be commercially practicable. An offset to this condition is our own obligation to secure for them such reception as shall be worthy of their talents. But our plans are not yet worked out, nor can they be until a later date.

It will be remembered that the Brunswick-Balke-Collender Company has been for some time selling talking machines, with built-in Radio Corporation sets. Both talking machine companies will now put out RCA. receivers. Mr. B. E. Bensinger, president of the Brunswick Company, states that the same special receivers furnished to the Victor Company will continue to be furnished to his company. He made the graceful gesture of complimenting the Victor Company on having followed out the same procedure as did his company the year previous.

When Great Men Speak of Radio

THE "electrical wizard" as Thomas A. Edison is frequently called, said in a recent interview: "Static can never be eliminated."

Perhaps this is so, but Mr. Edison's saying that it is so doesn't make it necessarily true. Many great men have been free in expressing their opinions on subjects they didn't understand. The American public apparently wants to believe that a man who has accomplished such great things as has Mr. Edison can give a reasonable opinion on many other things. So in considering Mr. Edison's views on radio, let us remember Mr. Ford's peace ship which was "to get the boys out of the trenches before Christmas." Mr. Ford didn't understand the war situation and



AN ENGLISH RADIO CONSTRUCTOR
Master J. H. Facer, aged 16, with his entries in a recent radio exhibition held in London

possibly Mr. Edison does not understand all the intricacies of radio.

Does Radio Need a High Commissioner?

THE idea of a unified control of baseball by Judge Landis, voluntarily vesting in him autocratic power in regulating all disputes which may arise, is a good example of an ingenious American plan to regulate and control a very difficult situation. The movie industry voluntarily put itself under the same kind of control. But of all the things requiring control of this kind, radio certainly stands foremost. In no field that we can think of is there more cause for disputes which will react to the detriment of the listener. To be sure, Herbert Hoover has shown great tact and diplomatic skill in arranging the past three international radio conferences, successfully bringing into line various conflicting opinions, both national and international, but his authority is by no means as powerful as that of the baseball Commissioner.

But our high commissioner idea has been so well thought of in Europe that radio there has just adopted it and all radio conflicts hereafter will be settled by one man who holds his position at the request of the various radio interests. Sitting in Geneva, where so many international movements seem to centralize, Mr. Arthur Burrows, an Englishman, will adjudicate all radio conflicts which originate in Europe.

This new international radio bureau, which Mr. Burrows heads, aims "to establish an effective link between the various European broadcasting stations, keeping in view the possibility of activities being extended to other continents; to defend all policies and measures affecting stations' interests; to centralize the study of all questions arising from the rapid development of wireless telephony and to initiate and further all efforts towards the improvement of broadcasting generally for the benefit of all nations both individually and collectively." From this statement it will be seen that head of the bureau automatically becomes the Landis of radio.

The bureau intends at once to interest itself in the question of radio relaying, a problem of ever increasing importance. More and more, as we see it, the tendency will be to do away with the talent of Main Street. We shall send out instead the most artistic performances obtainable. This accomplishment of course is possible only by some scheme of relaying. The European bureau intends to be itself a direct channel for the interchange of programs, ideas, and regulation of all matters directly affecting radio broadcasting.

ROBERT M. FOSTER

Of Montreal, Canada, the radio operator aboard the Canadian Coast Guard ship *Arctic* which sailed for Etah, Greenland the latter part of June. He will experiment on 20, 40, and 80 meters, using the call VDM. Short wave experiments with Canadian and American amateurs and KDKA, East Pittsburgh were very successful during the 1924 expedition and more extensive tests are planned this year. The two ships of Donald MacMillan's Arctic expedition will also be in the same waters at about the same time. The MacMillan vessels are equipped with short wave telegraph transmitters also

Radio Broadcast's Phonograph Receiver

THE two great centers of home entertainment are without question the radio and the phonograph. For the past four years, the radio set has probably usurped the domestic center of attention and the phonograph has had to take second place. But now that radio constructors are a little less eager to build every new circuit —being attracted to it simply because it is "new"—the attention of every radio user has naturally centered on the appearance of his receiver. It is assumed that he has found a type of set which satisfies his daily radio wants.

It has been the aim of RADIO BROADCAST to produce a radio receiver for home construc-

J. C. GILBERT

Washington; Chief, Radio Market Service, Department of Agriculture

"Progress in the field of radio broadcasting must include a systematic organization of weather, crop, and market reports and helpful agricultural information. There must be greater coöperation between all agencies concerned. I should like to see some general instruction broadcast to farmers about their radio sets, and how they should be installed and operated. The surveys which the United States Department of Agriculture made in 1923 and 1924 showed that the use of radio on farms is increasing rapidly. 370,000 radio sets on farms were estimated for 1924 as compared with 145,000 in 1923. About fifty per cent. of farmer-owned radio sets are home assembled. This is not extraordinary, for people on farms have much experience in making their own tools and equipment. There is no group or class of people in this country to whom radio means so much as to the farmers."

tion which will satisfy the obvious requirements for practically every radio use: one that will deliver faithful service and one that readily can be built from standard and available parts. Further, we have tried to design this set so that it is easily made portable, if that be the desire, but chiefly to make it easy to install in the various types of phonographs found in American homes. These aims we are convinced we have attained in the Phonograph Receiver.

If the constructor has a phonograph of any one of the standard types which have been sold in such enormous quantities, the Phonograph Receiver can be built and installed with ease, and the phonograph will not be marred or made less useful in any way.

In fact, we feel that we have shown the way to make the phonograph doubly useful. To combine in one instrument the amazing breadth of entertainment the phonograph affords and the instant and vital daily entertainment that is the charm of radio is an accomplishment which should interest every one who sets store by his home and all that therein is. Our correspondence shows that our solemnizing the marriage of the phonograph and the radio has met with very widespread approval.

Reform Is Needed in Radio Advertising

THERE is no doubt at all that radio has a rather unsavory reputation with much of the buying public. We are continually asked about "what set to buy," and find that the intelligent public believe little that is written about the merits of this set or that one. The reason for this disgust is at once evident to one who picks up an average radio magazine or newspaper and looks over the radio advertisements. There is apparently no set that isn't the best, no condenser that hasn't the lowest loss, no coil that isn't the most efficient. Obviously they can't all be the best. The reader naturally distrusts all of them.

The average radio advertisement is not an honest attempt to tell just what the apparatus will do, but rather a claim that it is better than that of any other advertiser. The "low loss" advertisements which have filled the magazine pages for months past are enough to demoralize any prospective purchaser. Each condenser has such low losses that this or the other laboratory found it impossible to measure them. Even if it were so, the fact remains that the purchaser could not tell the difference between perhaps twenty different makes, in so far as condenser loss is concerned. The losses in the coils (which always must be used with condensers) are so much greater than those of the condenser that any one of twenty good condensers will act practically the same in so far as strength of signals is concerned.

When it comes to complete sets, the situation is much worse. Were one to believe the extravagant claims made by dozens of manufacturers he could take a set home and after about ten minutes time spent in installation, hear practically any station he wanted to from one coast to another. But this isn't the truth and many a purchaser has been grossly

deceived by advertisements interested only in immediate profit.

Isn't it about time that radio advertising settled down to a more reasonable basis? Extravagant and foolish claims will eventually only hurt a product and undoubtedly those advertisers who state sanely and reasonably what their apparatus is designed to do, and under what conditions, will in the end gain the confidence of the buying public.

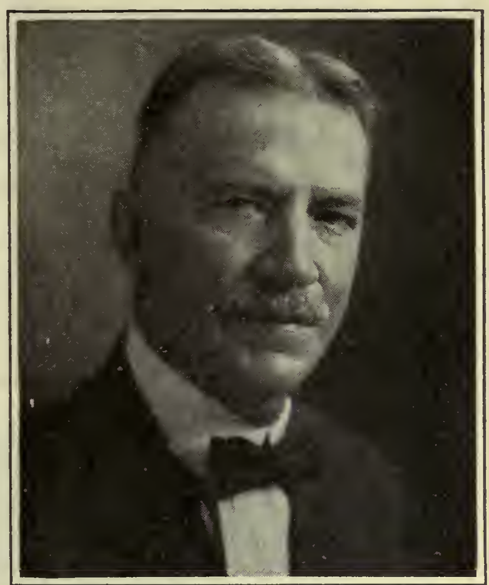
Interesting Things Interestingly Said

SIR ROBERT FALCONER (Toronto; President, University of Toronto; in an address at Edinburgh University): "It is the theatre, the moving picture show, and the radio which are exercising the most penetrating and subtle influence upon the social standards of Canadians. . . . Every night thousands of young Canadians listen to addresses and talks directed to the people who live in the central cities of the United States. As immigrants from Europe have precisely the same character and outlook as those who have made their way into the United States pour into Canada, they will, through the constant repetition of similar ideas in picture, play, illustrated paper, and radio, soon be a type that will no longer be Canadian. . . ."

HUGH S. POCOCK (London; editor *Wireless World*): "The strongest ties exist between the radio amateur of this country and America. The first long distance communication employing short waves was achieved between Europe and the United States by amateurs, and although France succeeded in reaching America first, British amateurs quickly followed, and since that day, two-way direct communication has been permanently established with many friends on the other side. . . . It is impossible to overestimate the importance of the American section of the amateur fraternity. Their organization, the American Radio Relay League, is without parallel in the world. In no other country is such freedom extended to amateur activity or such use made of the facilities so granted."

DR. ARTHUR H. HAMMERSCHLAG (New York; president, The Research Corporation): "The greatest scientific advance in 1924 was in the field of communication—in radio and in radio photography."

CAMILLE FLAMMARION (the late French astronomer): "We might communicate with Mars by some other means than light and optics. Who can predict the future progress of science? Can we say that the Martians have not already tried by means of radio-telegraphic waves? Whence come certain unexplained disturbances of wireless telegraphy? Perhaps from the sun, the effects of whose electric storms extend as far as the earth. Yet, for all we know, they may come from another source."



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D. B. CARSON

Commissioner of Navigation, Department of Commerce

"The public probably will continue to contribute to broadcasting liberally through the cost of equipment purchased. At present, there does not appear to be a more equitable way of distributing the cost while, on the other hand, such stations must have considerable advertising value, justifying the expense of operation where the owners of the stations gain their support through the sales of radio apparatus."

LORD DAWSON, OF PENN (London; personal physician to King George; in an address to visiting American physicians): "The central reason for the stress of modern life is our material progress. The movement has been so rapid that it has outstripped our rate of adaptation. The internal combustion engine, the telephone, and the wireless have so tuned up the modern man's mind that he remains in the same key when he is at work and when he takes his so-called play."

A. ATWATER KENT (Philadelphia; radio manufacturer, who broadcast from the *Los Angeles* on her recent flight over Philadelphia): "I hope there will be more broadcasting from airships. The people will, one may be sure, listen eagerly to brisk narratives of flight while the flight is actually taking place. Certainly those who were permitted to speak into the microphone on this first broadcasting voyage of the *Los Angeles* were thrilled."

For the Radio Beginner

Adding a Bulb to the Beginner's Crystal Set

A CRYSTAL receiver does not survive very long in these days of inexpensive vacuum-tube apparatus. But its short existence serves a purpose by initiating the beginner into an intelligent appreciation of radio elements and stimulates a desire for something better.

The crystal receiver described in this department last month, having served this creditable purpose, can be converted into a bulb set at an expense little in excess of its original low cost. The converted receiver will be more selective than before. This is because the resistance imposed by the crystal is eliminated. Resistance added to any tuned or resonant circuit broadens the tuning of the circuit. Also the receiver will be more sensitive and the signals more loud due to the superior efficiency of the bulb as a detector.

A Course for the Radio Beginner

¶ On page 366 of RADIO BROADCAST for July, a simple crystal receiver was described which could be built from parts bought at the five-and-ten-cent store, at a total cost of $1.82. The set will receive good broadcast signals from near-by stations. This month, a vacuum tube which will increase the receiving range of the set is added to that assembly.

¶ In this department also is begun a series of simple explanation of some of the simplest radio phenomena. What "detection" means is the subject of explanation this month.

¶ Additional help for the beginner is found in "The Radio Lexicon" which simply defines all the radio terms used in this article. "The Radio Library" recommends chapter and verse in good radio text books which cover more fully the same ground as this department.

¶ Zeh Bouck, one of the ablest radio writers in the country, is preparing this department. Mr. Bouck is an amateur himself of long experience and sympathetic mind and has passed through the stages of trial and error, of seeking and finding which all radio enthusiasts experience. He is known on the air and to readers of the New York *Sun* AS 2 PL, author of the column "What Are the Air Waves Saying?" and to readers of *Boy's Life* as editor of its radio department.

—THE EDITOR

THE PARTS WE NEED

THE necessary parts for the conversion of the Beginner's Crystal Receiver described in this department for July, 1925 into a one-bulb set, are photographed in Fig. 1. The lettering is that conventionally employed in diagramming the various parts. The items and their prices are:

No. 1	Socket (receptacle)	.10
No. 1	Socket (screws and springs)	.10
No. 2	One 30-ohm rheostat	.25
No. 3	UV199 Tube	3.00
No. 4	Grid condenser, capacity .00025 mfd.	.10
No. 5	Grid leak mounting	.10
No. 6	2-megohm grid leak	.10
No. 7	Burgess small 22.5 volt B battery	1.22
No. 8	3 dry cells at 35c. each	1.05
No. 9	4 Binding posts	.10
		$6.12

With the exception of the tube and batteries, all parts were purchased in the 5, 10, and 25-cent stores. The cost of the crystal receiver described last month with the addition of a good pair of phones and antenna equipment was $5.52. Thus the expense of the combination crystal—bulb set, including all equipment, is less than $12.00.

THE CIRCUIT

FIGURE 2 shows how these simple parts are connected together and how they are wired to the crystal set described in this department last month, or to any similar receiver. The heavy lines on the right hand side indicate the connections between the new apparatus. One side of the grid condenser (C) is connected to the grid (G) post on the socket, and the grid leak mounting is connected across the condenser. The grid leak (R2) is clipped into the mounting. The plate (P) binding post on the socket is run to a binding post (D), which, with post C

affords the B battery posts (D and C) for the set.

The rheostat (R1) is connected to one of the filament (F) posts on the socket. The remaining filament post and rheostat post are run to set binding-posts respectively for plus and minus A battery connections (A and B).

The bulb apparatus can be connected to almost any crystal receiver in the following manner, and in accordance with the dotted lines in Fig. 1.

The minus B battery post (C) is led to that side of the crystal detector nearest to the telephone receivers ("X" in the case of The Radio Broadcast Beginner's Set). The free terminal of the grid condenser leads to the other side of the crystal detector ("Y" on the Beginner's Set). The plus filament lead is connected to that side of the telephone receivers farther from the crystal detector, or ("Z" in the Beginner's Receiver).

CONSTRUCTION OF THE TUBE RECEIVER

IF IT is desired to add the bulb to any crystal receiver other than that described on page 366 in RADIO BROADCAST last month, the mechanics of the arrangement will be left to individual invention. The parts may be mounted into a separate unit if desired, or

FIG. 1
Complete equipment for changing any crystal receiver into a single-bulb set. The apparatus photographed here costs $6.12. The dry cells are wired in series, forming the A battery

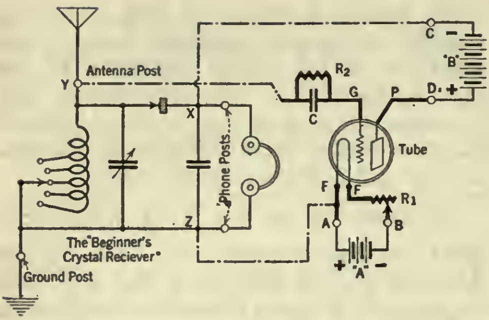


FIG. 2

The connections. The heavy line indicates the wiring of the new apparatus, and the dotted lines show how it is connected to the RADIO BROADCAST Beginner's Set

perhaps room can be found for them in the set proper as is the case with specific crystal set to which we have already referred.

The photographs, Figs. 3, and 4, clearly indicate how the single tube was combined with the crystal receiver. The combination can be effected with the same tools suggested for the original construction of the tuner.

The socket and rheostat are mounted on the top of the cigar-box cabinet and the extra binding posts two on each side. The remainder of the parts—the grid leak, its mounting, and the grid condenser—are placed inside the cabinet.

The socket and rheostat are mounted on the center line of the top of the box, with centers two and one quarter inches in from the ends. The socket is mounted with two wood screws, and the rheostat with the screws provided for that purpose. Rather than bring the wires through the "cabinet" top to the outside posts of the socket, four small holes were drilled underneath the socket prongs through which the connections were made. The wires were secured under the heads of the screws that project through the base of the socket as binding posts. The battery binding posts are mounted directly behind the antenna, ground, and phone terminals on the original set—about $\frac{5}{8}$ inch in from the rear edge. The A battery posts are behind the antenna and ground posts. These arrangements are clearly suggested in Fig. 3.

The grid condenser and grid leak mounting have the same spacing between mounting holes, so they were combined into a single unit as shown in Fig. 4. The condenser and mounting are held firmly in place by the connecting wires. A few feet of No. 18 bell wire were used in making connections.

No solder need be used in making this set an electrically efficient job.

NOTES ON OPERATION OF THE SET

THE finished receiver is a combination set. It can be operated with either crystal or bulb detector. When the crystal is adjusted *and the rheostat turned off*, the set will receive as well as ever on the crystal. When the tube is used, the rheostat is turned on and the catwhisker *must be lifted away from the crystal.* With this latter arrangement, the receiver functions as a single-tube *non*-regenerative set. Single-tube regenerative sets are radiators of interfering oscillations, particularly when operated by inexperienced listeners. For this reason, no slight alterations should be attempted in order to make the receiver regenerate.

The three dry cells forming the A battery are connected in series—i.e. the negative post of one cell to positive post of the next, as suggested in Fig. 1. The negative terminal is the zinc, and the positive terminal is the center or carbon. The A and B batteries are connected to their respective posts.

With new or fully charged batteries it will be necessary only to turn the rheostat "just on." As the A battery is discharged—in the course of a month or two—the rheostat must be turned farther and farther up. The operation of the set as a bulb receiver in respect to tuning is identical with that of the crystal set.

The tube should be turned off by means of the rheostat when the set is not being used.

THE RADIO PRIMER

What "Detection" Means

IT IS impossible to start at the very beginning of things. To all adult arguments and explanations, some premises must be granted. Before beginning to explain the necessity for a form of detector such as the crystal, certain conditions under which the detector operates must be admitted even when, by some, they may not be thoroughly understood.

In every receiving set, and therefore in a crystal receiver, a high frequency alternating current flows through the tuning circuits whenever a transmitting station is being received. This high frequency current is identical in every respect except in strength with that surging in the transmitter many miles

distant, and is set up in the receiver through the action of the radio wave. When the current grows more powerful in the transmitter, it grows similarly more powerful in the receiver. Every variation of the transmitting current is duplicated, at practically the same time, in all receiving sets tuned to this transmitter.

Now these variations are caused by different tones and notes impinging on the microphone in the studio of the transmitting station. With one note, the transmitting current will grow stronger, while on another it will be weakened. Thus, in the receiving set, we shall have an alternating current, the strength of which will vary with the spoken words or music picked up by the small round microphone in a broadcasting station perhaps a thousand miles away. This alternating current is conserved and brought to its maximum stength in the receiver by the process of tuning. When you twist the dials of your receiving set, you are merely adjusting local conditions so that the most can be made of the infinitesimal energy which you pick up many miles from its starting point.

MAKING ALTERNATING CURRENT "AUDIBLE"

HAVING picked up, conserved, and, perhaps, strengthened this weak alternating current, it now remains to make it audible—to conjure it forth from the loud speaker or telephone receivers as enjoyable sound. This process is well named "detection," and it is here that the "detector" (a crystal in this case) comes into its all-important action.

A high frequency alternating current will not actuate the diaphragms of a loud speaker or telephone receivers. Both of these instruments severally consist of a permanent magnet over which are wound several thousand turns of wire. When electricity passes through these turns there exists the combination effect of a permanent magnet, such as the familiar horseshoe magnet and an electromagnet, such as the bobbins that actuate the armature of an electric bell.

All magnets have two poles, and the lines of magnetic force are imagined as leaving one pole and entering into the other. Thus the magnetic lines of force may be said to be characterized by direction, running, as it happens, from the north pole of a magnet to

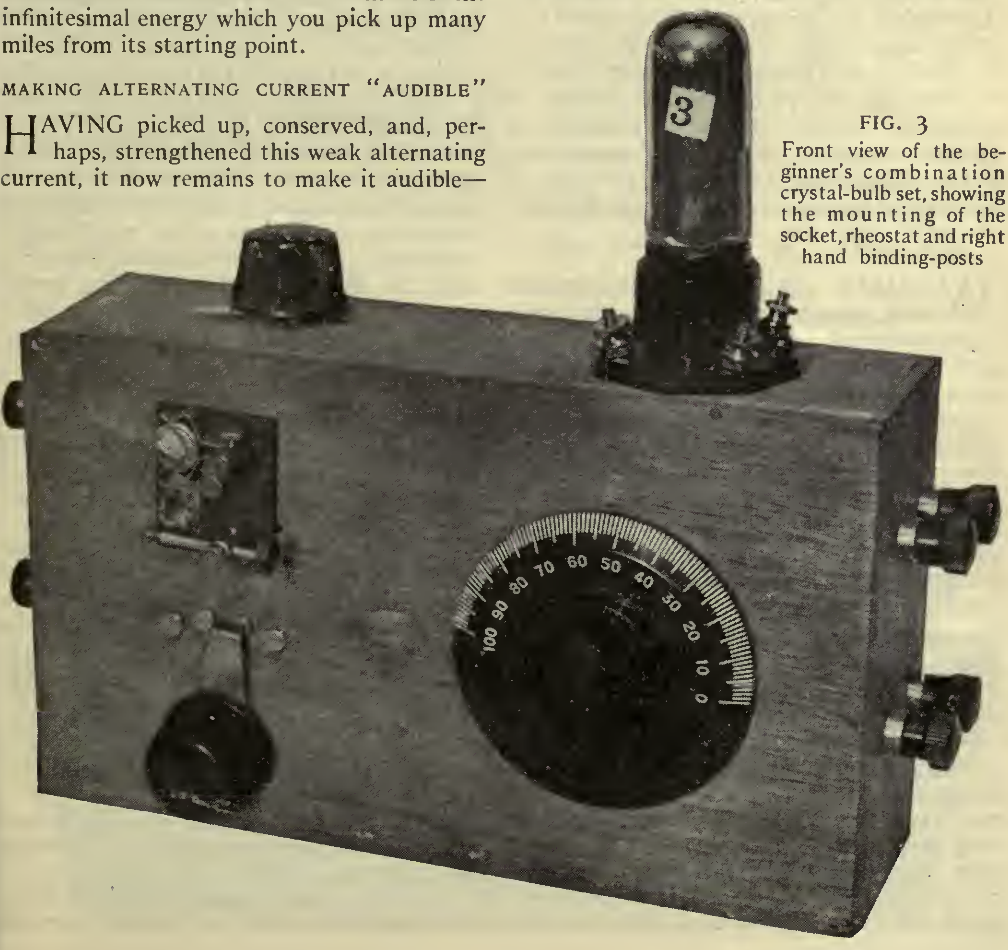


FIG. 3
Front view of the beginner's combination crystal-bulb set, showing the mounting of the socket, rheostat and right hand binding-posts

the south pole. The directions of the lines of force in an electromagnet are determined by the direction of the current flowing through the winding. When the direction of the current is reversed, the magnetic field is reversed.

An alternating current, as most of us appreciate, is a current that reverses its direction of flow many times a second. For a fraction of a second it courses through the wire or conductor in one direction. Then it weakens to zero strength, and turns about, growing stronger in the opposite direction. Its action is comparable to the motion of a piston actuating a revolving flywheel. The piston is constantly reversing its direction of motion (one reversal for every revolution of the wheel) and yet it continuously exerts a power or force that is useful. The number of times this reversal takes place is known as its frequency.

Therefore, if we pass an alternating current through the coils of an electromagnet, the direction of the lines of force, comprising the flux or magnetic field, will reverse with the alternations of the current. The action of this field is suggested in the drawings Fig. 5.

The field of a permanent magnet is, as its name suggests, permanent. It exerts a magnetic attraction without the assistance of electric current, and, excepting under very powerful electrical stresses, the polarity, or direction of the lines of force, is never reversed.

THE "WORKS" OF THE LOUD SPEAKER

WE HAVE said that the diaphragm of a loud speaker or telephone receiver is actuated by a combination of permanent and electromagnets. Let us investigate what would happen if we pass a high frequency alternating current through the winding of such a reproducer. In one direction of current flow, the electromagnetic field will assist the permanent magnetic field, and the diaphragm will be drawn farther down toward the magnet. However, with the reversal of the current (and accompanying reversal of the electromagnetic field) the electromagnetic field will oppose the permanent field. This will result in the weakening of the permanent field, and the diaphragm will spring away from the magnet even beyond the point of normal equilibrium (when there is no current flowing through the winding). Thus with every cycle or complete alternation of the current, the diaphragm will move toward and from the magnet. But in high frequency radio currents used in broadcast transmission, these alternations take place anywhere from 300,000 to 6,000,000 times per second! Due to inertia, it is impossible for so heavy an object as a diaphragm to reverse its motion this many times a second, and even were it possible for the metal disk to vibrate so rapidly, the frequency is far above the upper limits which the ear can detect as sound.

It is therefore necessary to rectify the high frequency alternating current, to change it into direct current, i.e., a current that flows only in one direction. Such a current will continuously oppose or assist (the more efficient arrangement) the permanent magnetic field, either releasing the diaphragm or pulling it more powerfully, respectively, as long as the current flows. It is only with a variation of the current, which it will be remembered changes with the sound impulses picked up by the microphone in the transmitting station, that the diaphragm will move, thus reproducing the sounds spoken, sung, or played in the distant studio.

Many crystals, such as galena or silicon, possess the property of unilateral conductivity, which means that they will conduct an electric current better in one direction. If an alternating current is applied to a circuit containing a properly connected crystal, the alternations in one direction will be passed quite readily, while those in a reverse direction will be weakened and impeded. This is a sort of automatic valve action, passing one half of the alternating current cycle and repulsing the other half. The final effect is that of rectification, the changing of the alternating current into a direct or uni-directional current, which is effective in actuating the telephone receivers or loud speaker.

THE RADIO LIBRARY

THE action of the crystal detector has been covered from various points of view in the following references. The student reader can obtain these books from up-to-date public libraries, and will find the indicated chapters well worth the reading.

The Outline of Radio, by John V. L. Hogan, pages 147 through 161. A very interesting and non-technical exposition on the necessity for detection and the action of the crystal rectifier.

The I. C. S. Radio Handbook, pages 174 through 180. A less elementary description of crystal and similar detecting actions.

Principles of Radio Communication, J. H. Morecroft, pages 336 through 350. A highly interesting

but mathematical exposition recommended to the student.

THE RADIO LEXICON

Important technical terms and words used in this month's department for the radio broadcast beginner:

ALTERNATION: Specifically, the reversal of an alternating electric current.

CRYSTAL DETECTOR: A detector of radio signals that functions by means of the rectifying property of some mineral such as galena or silicon.

CYCLE: The complete motion of an alternating current, from the beginning of one alternation to the end of the next.

DETECTION: The process of making audible the radio frequency currents set up in a receiving set by the passing radio wave.

DETECTOR: The instrument or group of parts arranged into a unit that performs the act of detection.

ELECTROMAGNET: A magnet about which lines of force are set up by a current

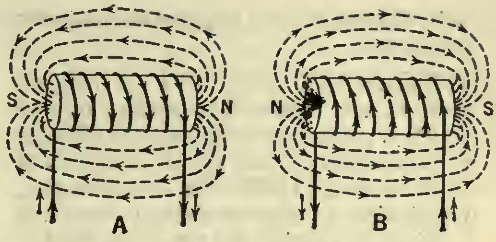


FIG. 5

Suggesting the manner in which the direction of the magnectic lines of force reverse with a reversal of current in an electro-magnet. The arrows on the solid lines indicate the direction of current flow in the wires, while the arrows on the dotted lines of force show the direction taken by the field. In A the current flows in one direction, which is reversed in B

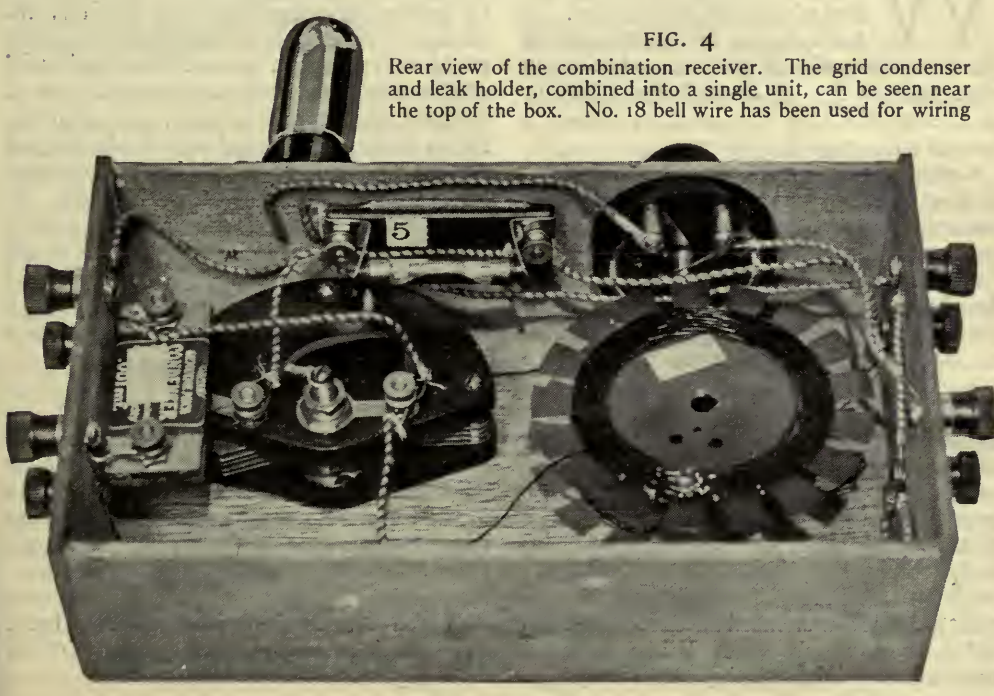
passing through its winding. The bobbins of a door-bell are electromagnets.

FREQUENCY: Broadly, the number of times a phenomenon repeats itself within a given time. In electricity, "frequency" generally refers to the number of cycles per second of an alternating current. In sound, "frequency" means the number of air vibrations per second.

LINES OF FORCE: More or less imaginary lines of magnetic energy running from the north pole of a magnet to the south

FIG. 4

Rear view of the combination receiver. The grid condenser and leak holder, combined into a single unit, can be seen near the top of the box. No. 18 bell wire has been used for wiring



pole, the sum total of which is the magnetic flux or field.

PERMANENT MAGNET: A magnet, such as the common horse-shoe magnet which is permanently magnetized through a peculiar disposition of the molecules of steel or iron. Unlike the electromagnet, no winding, passing an electric current, is required to provide the attracting field.

RECTIFICATION: The changing of an alternating current to a direct current, generally by passing one half the cycle (all motion of the alternating current in one direction), and impeding the other half.

SELECTIVITY: The ability of a circuit or receiving set to eliminate undesired stations, while bringing in the desired signal.

SHARPNESS: The criticalness of tuning. A set that tunes sharply will tune a station in or out with a degree or two of variation on the tuning dials. Sharpness does not mean "selectivity," The use of a large variable tuning condenser will sharpen tuning without affecting selectivity.

Wavelength or Frequency—Which?

In An Effort to Clarify Radio Terminology, RADIO BROADCAST Will Hereafter Refer to Frequencies Instead of Wavelengths

BY J. H. MORECROFT
Past President, Institute of Radio Engineers

WE ARE all, being human, naturally very loath to give up one line of thought for another. It has taken a certain amount of effort to accomplish a method, and common sense tells us not to discard one habit, or scheme of thinking for another, unless a marked advantage is evident.

A most remarkable illustration of this mental inertia is our present system of units for measuring, in the so-called English system, and our hodge-podge method of spelling words.

So many times, as the writer has witnessed the efforts of school children trying to master the crazy tables of measuring units with which an elementary arithmetic is loaded, the thought has occurred to him, "How inefficient and useless is this antiquated method we have of measuring things in everyday life!" Gills, hogsheads, rods, miles, drams, ounces, and pounds, with their heterogeneous relationships, unnecessarily take up a tremendous amount of time and effort of the young student. Just because his parents haven't had the courage to break away from unit systems bequeathed by semi-civilized ancestry (apologies to Mr. Bryan) the boy of to-day has to spend many a dreary hour learning tables of quantities which had much better be replaced by others. If the metric system of units could be universally adopted in this country, the amount of time spent on arithmetic in schools might very likely be halved. But the father of the schoolboy, having an expensive set of jigs, fixtures, machines, bolts, and whatnots in his factory all worked out on the English system, does not contemplate with equanimity changing his scheme of measurement. It would temporarily seriously affect his profits. And so, through the land, millions of boys and girls continue to expend many of their precious hours memorizing useless relationships which could readily be replaced by others much simpler.

WHEN CHANGE IS DESIRABLE

EVEN a lethargic reader can see that change is many times useful and desirable. Now when radio began, the effort was made to identify electric disturbances with light, and naturally this branch of electric science took over the nomenclature of the physics of light. The various frequencies used in radio were identified by their wavelengths, as in light. So radio folk grew accustomed to speak of the wavelength of an alternating current.

The student of radio to-day finds that he has to start with the elementary laws of the alternating current circuit and in these laws he finds that the frequency of the alternations plays a very important part in the action of the current. He finds that commercial alternating currents have frequencies of 25 to 60 cycles per second, voice (or telephone) frequencies from 100 to 10,000 cycles per second. He becomes accustomed to thinking of these currents in terms of their frequencies. He learns in telephony that one frequency can be separated from another by so-called filters, the theory and action of which is explained in terms of frequencies. In carrier telephony, using frequencies perhaps as high as 50,000 cycles per second, the engineer still thinks of frequencies. Instead of speaking of 50,000 cycles he speaks of 50 kilocycles, adopting the metric system of easy conversion from one size unit to another. The electrical engineer long ago found it convenient to use the kilowatt instead of the watt, and all electric bills are now rendered for so many kilowatt hours, as every householder knows.

There is no reason at all for speaking of radio currents in wavelengths. All the theory and apparatus of the radio engineer is worked out on the idea of frequency. The Bureau of Standards early recognized the needless complexity and the uselessness of the wavelength unit and in all of its publications now uses the frequency of the radio current instead of its so-called wavelength.

THE DISADVANTAGES OF WAVELENGTH

IT SO happens that in broadcasting, the term wavelength has an added disadvantage, one which argues most strongly for change to the frequency unit. A broadcast telephone channel requires a certain width of the frequency scale to transmit the voice properly. An ordinary station rated at 500 kilocycles, for example, requires a frequency band from 490 to 510 kilocycles for perfect transmission of speech. This width of frequency band, of say 20 kilocycles, is required for radio telephony no matter what the frequency of the station's current may be. Thus a station at present rated as 150 meters wavelength requires a frequency band from 1990 kilocycles to 2010 kilocycles, a band the same in width as for the 500-kilocycle station. If we continue to think of wavelength, however, we shall find no easy way of telling how closely two stations might be tuned without interfering with one another's channels. This separation would be 20 meters, perhaps, in one part of the radio frequency band and only 2 meters in another.

On the basis of 20-kilocycle separation, the Department of Commerce could assign frequencies every 20 kilocycles up the radio frequency scale, knowing that such assignments would not interfere. But if we stick to wavelength, we shall find the wavelength scale divided in a most irregular and apparently unreasonable manner.

Radio receiving sets can be made to have dials of uniform frequency scale. Dials and condensers of this kind are already appearing on the market.

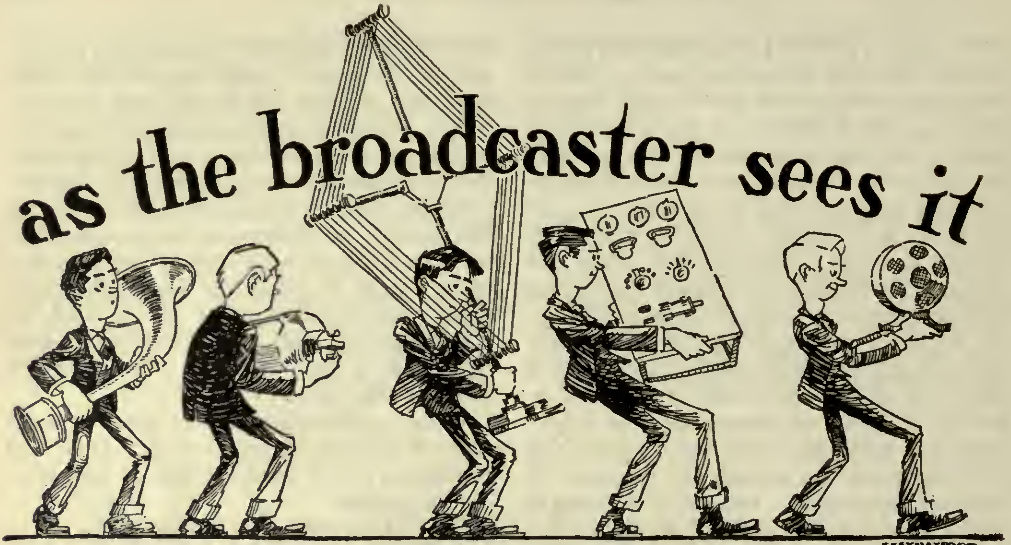
The Department of Commerce specifies radio station assignments in both kilocycles and meters. The tendency of radio engineering practice is to use and express frequency in kilocycles rather than wavelength in meters. "Kilo" means a thousand, and "cycle" means one complete alternation. The number of kilocycles indicates the number of thousands of times that the rapidly alternating current in the antenna repeats its flow in either direction in one second. The smaller the wavelength in meters, the larger is the frequency in kilocycles. The numerical relation between the two is very simple. For approximate calculation, to obtain kilocycles, divide 300,000 by the number of meters; to obtain meters divide 300,000 by the number of kilocycles. For example, 100 meters equals approximately 3000 kilocycles, 300 m. equals 1000 kc. 1000 m. equals 300 kc., 3000 m. equals 10. kc.

For highly accurate conversion, the factor 299,820 should be used instead of 300,000.

From this number of RADIO BROADCAST, reference in the magazine will no longer be made to wavelength alone. Frequencies will be the standard, but in order not to confuse the inexperienced reader, the corresponding wavelength will always be used, in parentheses.

Page 110, of RADIO BROADCAST *for November, 1924 contained instructions on how to convert wavelengths to frequencies and vice versa. The Bureau of Standards has available, for limited distribution, a conversion table, worked out on the factor 299,820.* —THE EDITOR.

as the broadcaster sees it



by CARL DREHER

Drawings by Franklyn F. Stratford

Diagnosis of the Radio Amateur

WHAT is a radio amateur? Great confusion surrounds the answer, if there is one. To owners of single-circuit receivers in his immediate vicinity, the amateur is a vicious ogre who emits strange buzzing noises which interfere with their broadcast reception. To commercial operators, he is a talented young man who might even aspire to become a commercial operator. To some of the amateurs themselves, who have taken their degrees as feature writers disseminating the gospel every Saturday afternoon in the radio supplements, the amateur is the inventor of radio, from the antenna insulators to the ground, in the past; its generous and disinterested supporter in the present; and its only hope in the future. To several score of other witnesses he is several score of other things.

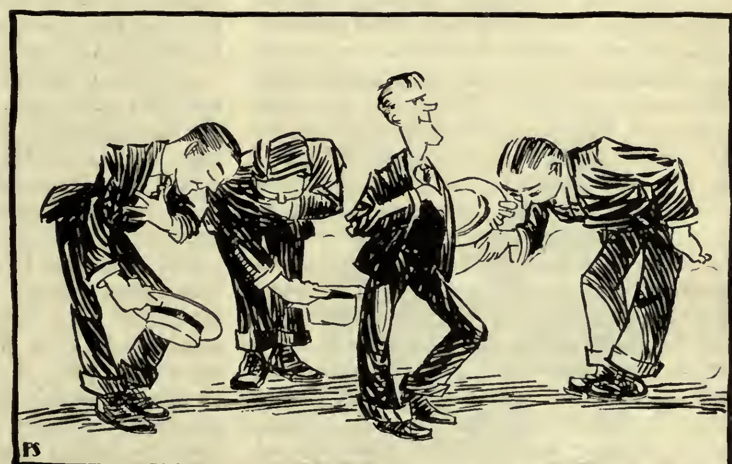
The dictionary, with its definition of an amateur as "one who is attached to or cultivates a particular pursuit, study, or science from taste, without pursuing it professionally," helps us but little. I venture to assert that from one third to one half of all the "amateur" radio men in the United States are making, or trying to make, money in the radio field, although not directly out of their activities as amateurs. That is, they make no money out of their radio telegraph activities, but they keep radio shops or service receiving sets or run broadcasting stations for pay. Yet they remain amateurs in excellent standing. Now we are beginning to see light. An amateur, in radio, is a person who experiments gratuitously with transmitting sets—generally radio telegraph transmitters—and with receivers adapted for communication with transmitting sets so tended; but who is free, without prejudice to his amateur standing, to make all the money he can out of radio otherwise. If he telegraphs around the country with just one set, and receives ditto, purely for the love of it, then his standing as a radio amateur is secure, and he can collect all the cash he is able to get in any other radio activities whatsoever. It is a unique conception, and as far as I know, peculiar to radio. The jealous differentiation between amateur and professional which prevails in athletics, for example, is entirely absent in radio. The boys out in the wheat belt, nursing along their five-watters because they can't afford replacements until they save up some more pocket money, and Mr. E. H. Armstrong, who has realized an amount said to run into six figures in royalties from his radio inventions, both claim the title of amateur, and are equally proud of it.

The fact is that one must look on amateur

radio as a species of freemasonry. The spirit of fellowship and brotherly sympathy is certainly there. If you don't believe it, attack the amateurs singly, or *en masse*, and see what happens to you. They are a scrappy lot, and if they ever fall, they will fall together. They have other lodge characteristics. They delight in titles, such as "Traffic Manager, Delta Division." These titles, while undoubtedly they mean something, and frequently involve a lot of work in the way of staying up until 4 A. M. relaying messages and preparing reports, do not carry quite as much weight or responsibility as the corresponding position in a quarter billion-dollar corporation. These dignitaries are somewhat on the order of the Grand Omnipotent Ruler of a lodge; he may be grand and all, but he isn't really omnipotent. And they write numbers and letters after their names, such as "Marcus Gavotte, 12 GHQ," which astound and flabbergast the laity, who imagine that these mystic designations are so many Ph. D.'s and Orders of the Bath, if not Congressional Medals of Honor. (As I write these sentences I can visualize innumerable Division Managers glowering at me across the country and sitting down at their "mills" to write me fiery letters. Peace, gentlemen! Before I get through you will hear such praise of your fraternity that your only impulse will be to catch the first train to Garden City for the purpose of decorating and embracing me.)

The telegraph code itself, while invented purely for the purpose of communication by symbols, and so used commercially, becomes, in the hands of the amateurs, a medium with something ritualistic about it, fulfilling a function not unlike that of ceremonies and liturgies in secret orders. Is the comparison far-fetched? If so, why do the amateurs use their lingo orally and in writing, at every opportunity? It is impossible for one saturated amateur to write to another in English; they get to a point where they must express everything in pigeon-Phillips (code) and Continental abbreviations. I should not be surprised to hear of one amateur walking into the office of another and asking him for a job in these words: "Sa OM QRW? I am QRXing for a job. QRU? Nil? Sorri tks 73s c u agn gb gb dit dit dit dah dit dahhh". This lingo is not used merely for brevity and convenience; it is also a philological toy, possession of which sets one off from the common herd. I am not immune myself. I have in my office a key-and-buzzer telegraph which communicates with other departments of the station, and, while its use is largely limited to acting as a calling device for a telephone line, I have noticed that it excites the admiration of lay visitors. No matter how busy I am, I am rarely able to resist the temptation to exchange reminiscences with an old operator, to dwell sentimentally on the never-to-be-forgotten note of HA, and to brag about the time when I could copy 35 a minute in 10-letter code.

But, aside from these factors, undeniably there is a certain magic in dots and dashes. There is a rhythm and lilt to the sending of a good operator which is capable of producing a definite esthetic response in a trained listener. It is even possible to put across rudimentary emotional states by variations and shading in the style of transmission. Even a novice can tell when the man at the other end of the circuit is impatient or angry or confused. Styles of sending are as numerous as the shapes of men's ears, and as varied as their ways of walking and talking. Many amateurs, as well as professionals, are connoisseurs of the subtleties of code work. Many others—probably the majority—are and will always remain rotten operators, just as the majority



let us dust the earth to the amateur

of people who learn to play the piano simply learn to murder the instrument and the music. There are always more dubs than artists. That there are artists among amateur radio telegraphers, no one who has any feeling for these matters will attempt to deny.

Neither would I deny that the traffic men of the American Radio Relay League sometimes try just as hard to get a message through as any commercial operator. But not one out of 500 such messages means anything. When anybody has a message he wants delivered, he gives it to a commercial telegraph company. The difference between the work of the amateurs and that of commercial interests is the difference between a sham battle and a real one.

A great deal has been written about the ingenuity of amateurs and experimenters in building their own sets, transmitting and receiving. It is true that some of them show immense skill, but things should be called by their proper names, and it is a fact that no amateur, experimenter, or other isolated individual is in a position to build even a simple radio set. He can only assemble one out of factory-built parts. What amateur or radio fan makes his own audio transformers, vacuum tubes, telephone receivers, plugs and jacks, bakelite panels? It is purely an assembly and wiring proposition. The creativeness of the amateur, therefore, is at best a secondary one.

Liberally mixed with hokum, also, are the vast and all-embracing claims made for the inventive genius of the amateur. To read some of these narratives, one would think that radio had sprung full grown out of the foreheads of a lot of sixteen-year-old geniuses. What first-rate radio invention has been made by an amateur? The work of Armstrong will immediately be cited. But at the time that Armstrong was doing his early work on regenerative circuits he was a student at Columbia University and had the run of the unexcelled Marcellus Hartley electrical laboratory on Morningside Heights. He did not yet have the degree, but he was already a distinguished electrical engineer in every other respect. However, instead of laboring the point, let us classify Major Armstrong's early work as an amateur achievement. What then? One swallow does not make a summer. What other first-rate radio inventions have come out of amateur circles? How many second and third-rate innovations, even? I know of few, very few. The unromantic fact is that most of the inventions that have brought the art to its present level have come out of well-equipped physical laboratories, after developing from the ideas of trained investigators and engineers. A great number have originated in the research departments of great industrial corporations, thence percolating down to the amateurs. The business of invention and research has become highly intricate, and is no longer carried on to the best advantage in a garret.

So much for the negative. Now let us give credit where credit is due. Given the inceptive ideas, the amateurs have again and again, with immense industry and ingenuity, developed fields of radio scarcely touched by other interests. The present short-wave fever is an instance. The value and specific utility of the very high frequencies is still only partly determined, but at any rate research in this field will yield interesting and important data. Men like Reinartz and Schnell are among the leaders in this experimenting. If they do not initiate the great theoretical and practical advances, the amateurs do undoubtedly mop up brilliantly in the immediate wake of the pioneers. Let an idea be published, and immediately a few thousand of them are at work squeezing the juice out of it, trying out all the variations, and showing that it can be made out of tin cans and empty tooth paste tubes.

Secondly, amateur experience is an excellent preparation for commercial activity in the radio field. Look up copies of the radio magazines of 1910 to 1914, and you will discover the names of many prominent engineers, commercial men, and operators of to-day signed to amateur articles. In another decade many of the younger amateurs of to-day will be running the works.

In time of emergency, this process is considerably expedited. During the last war, the signal services of both the army and the navy drew a sizable proportion of their personnel from the ranks of the amateurs. Some of these men required no training. Others needed only a fraction of the training which would otherwise have been necessary. The time thus gained was precious. Similar emergency service may be rendered by the amateurs in time of earthquakes, floods, or other disasters. A country with fifteen or twenty thousand more or less skilled telegraphers and radio signal men available as reserves behind the professional operating staffs, is that much better off when communications get into a jam.

Thirdly, the amateurs are amusing them-

selves, instead of paying someone to amuse them. They are playing ball, instead of watching someone else do it for $20,000 a year. Even if their activities were purely recreational, they could be amply justified. It is a good thing to get one's fun through one's exertions, rather than to have it served up, cooked and predigested, on a platter. Let us dust the earth with our hats in salutation to these young men who reach out six thousand miles, across seas and continents, for their amusement.

Why Summer Broadcasting is Better

ANOTHER reason for cleaving to radio throughout the summer, the argument in this case being addressed to symphony concert listeners:

A large orchestra sounds better, by direct audition, indoors than outdoors. The brilliancy of the strings is superior, and much detail is perfectly clear indoors, where it is partially lost outdoors except to those members of the audience who have seats well up front. (This is for the connoisseurs and great musical sharks; probably most listeners would not make the distinction.) But, by radio, a big outdoor orchestra is usually better than the same orchestra in an auditorium, owing to the relative absence of reverberation. Hence, for the best symphonic radio music, listen during the summer. You will get good stuff all year around, but the summer has, as the sporting writers say, the edge.

Daylight Broadcast Reception

MR. ALEXANDER L. SHERIDAN of South Raub, Indiana considers the night-day ratio of signal strength, quoted on page 76 of the May issue, as too high. This figure, it will be remembered, was quoted from the well-known paper of Nichols and Espenschied, wherein it appeared that the power of a broadcasting station would have to be multiplied by a figure of the order of 10,000, in order for it to supply the same signal at a distant point during daylight as the signal received at that point *during the best times at night*. With a standard superheterodyne receiver, using external loop and outside antenna combinations, Mr. Raub is able to hear WGY, WCAE, and KDKA, day and night. At the time he wrote (April), WEAF, 800 miles away, was audible, although not quite understandable, at noon. During the preceding December, and January, states Mr. Raub, he was able to hear WEAF on a loud speaker any time after 2.30 P.M. S. C. T., and to determine the nature of the material broadcast. WEAF's power at this time was 1.5 or 2.0 kw. Accordingly, our correspondent does not believe that the discrepancy between day and night reception is as high as reported.

These observations are very interesting, and, certainly, data on daylight reception is most welcome, being rather scarce in the broadcast field. However, there is little in the above data to discredit the observations of Messrs. Nichols and Espenschied, and any one who knows these engineers and their methods of procedure would hesitate a long time before challenging any of their results. In our quotation we were careful to retain the qualifying clause relative to "the best times at night," those periods, that is, when the signal rises to a peak value based on an inversely-as-the-first-power-of-the-distance attenuation. Normally the received signal drops off according to a higher power, owing to the absorption it encounters along the way. Sometimes, at night, through the fortuitous and uncontrollable action of meteorological forces in the great open spaces, this absorption is wiped out for a few seconds. These are the crowded moments for which the DX hunter prays; their occurrence is his glory, their brief duration and rareness make him miserable. All that Messrs. Nichols and Espenschied said was that to duplicate that transitory night peak with a continually serviceable daylight signal of the same strength, over the same distance, you would need 10,000 times as much power. I believe you would. All that Mr. Raub has shown is that, given the

they learn to murder the instrument

almost incredible sensitivity of the modern super-heterodyne, one can hear the higher-powered broadcasters over very considerable ranges in daylight, a fact which no one will dispute.

It should be noted that in this discussion the important distinction between hearing a signal well enough to log it, and getting it well enough to justify use of the term "program service," has not yet been introduced. At the risk of wearying our readers, we once more point out the necessity of clearly understanding what we are talking about in this respect. The interest of this department, and our whole manner of thinking about radio problems, generally centers about program service rather than catching on the fly some distorted sounds which are here now and gone the next minute. This is not to say that one cannot have a lot of fun with DX signals; a few million people are ready to testify that one can. But the serious development of radio is clearly in the direction of immaculate program service for an ever increasing number of people. By such service we mean a signal of about phonograph volume, at least as good as the best phonograph quality, and free from annoying disturbances, natural and artificial. Hence the trend toward higher powers. Hence the usefulness of quantitative data covering both day and night conditions in broadcast reception.

The Memoirs of a Radio Engineer, III

(Continued from the July Number)

OCCASIONALLY rumors came our way of the wonders and potentialities of "wireless." A seventeen-year-old cousin of a friend of a member of the gang was said to be telegraphing across his back-yard in Yonkers, without the use of wires between the two stations, although there was plenty of wire at either end. Another enthusiast had erected an antenna on his roof and was engaged in what he called transmission, using a spark coil, until his mother happened to come in contact with that antenna while she was engaged in hanging out the wash. His experiments were abruptly terminated, and the subsequent spanking was said to have been of volcanic violence. Another inventor, according to reports, was engaged in destroying nickels, and even a dime, with a file, in an endeavor to construct a "coherer." We did not know what the coherer was supposed to do, but we were agreed that the only explanation of the experimenter's conduct was madness. Would any sane boy attack a dime with a file?

Nevertheless, we were not sure. Possibly the fellow expected to realize some special raptures through his sacrifice. Wireless began to appeal to our imaginations. Thereupon, of course, we were lost. We had to have a "wireless."

We secured a piece of glass tubing, two nails, and a nickel. Securing some filings from the coin, we placed them between the two nails, and, according to the books, we had a coherer. An electric bell, wired for single stroke operation, was the decoherer. But we had no relay, and there was not the slightest chance of acquiring one. Furthermore, there was no transmitter, and therefore nothing to receive. Finally, while it was possible to get clear and detailed information from the boy electrician books about batteries, sounders, motors, and the like, the data on wireless was fragmentary, and we suspected that the authors knew little more about it than we did. After a period of despair, we were saved by a description of an "auto-coherer," consisting of a carbon and a steel rod in contact with a drop of mercury within a glass tube. It was said to have been invented by Marconi, and to be in use in the Italian Navy. The virtue of this instrument was that it was sensitive and would operate a telephone receiver. We had two seventy-five-ohm receivers of the "watchcase" type; one of the boys had got them as a Christmas present, and we had constructed a primitive telephone line with them in the intervals of our telegraphing. The materials for the auto-coherer were obtainable. The nail and glass tube we had. With a hacksaw blade we cut a carbon rod out of an old dry battery carbon, and filed it down to approximate roundness. The physics teacher in the elementary school gave us a few drops of mercury. To our delight and astonishment, the detector worked. The telephone receiver being connected to it, the discharge of a Leyden jar in the next room could be heard as a distinct click. One could send dots with it, but no dashes. We arranged a set of signals on this basis. In order to send even one dot, of course, it was necessary to charge the Leyden jar with the electrophorus, which took several minutes. It was not high speed telegraphy, but it was "wireless," undeniably.

We now heard of a still simpler and even more sensitive form of detector of the microphonic type. This consisted of two steel needles, stuck into a piece of wood and pro-

vided with leads, and a piece of pencil lead laid across them. It worked with a telephone and a local battery. It was said that, placed on a cigar box, it would register the noise made by a fly walking across the box. We placed it in this position and waited patiently for a fly to promenade thereon. But the flies were wary. It was necessary for us to catch a beetle, and, indeed, he was quite audible in the telephone receivers as he scampered off the box. But this was not wireless, we realized. It was a digression.

At this time (early in 1909), there were already wireless amateurs who had reached a stage much in advance of ours. In the same year they founded the "Junior Wireless Club, Ltd," with headquarters at the Hotel Ansonia, where the President, W. E. D. Stokes, Jr., had his home and antenna. The history of this group was graphically described by my friend George Burghard, now President of the Radio Club of America, in "Eighteen Years of Amateur Radio," (RADIO BROADCAST, August, 1923). These were the genuine amateur radio pioneers in the East. Some of these boys had started experimenting as early as 1905. They were about four years ahead of us, and some five years behind the commercial radio pioneers of this country. Our group in upper New York might therefore be classified as part of the third pioneering migration with some of the ground already cleared and the Indians no longer on the offensive. But we were on our own. We had no contacts with the West Side aristocracy of radio amateurs, whose resources and facilities were far superior to ours, enabling them to establish two-way communication over distances up to a mile at about this period.

However, we heard of an amateur about a third of a mile from our location, who had a transmitting set consisting of an antenna, a spark coil, spark gap, key, and battery. He was languishing for someone to listen to him. If we would put up an antenna, he would send to us. This appealed to us irresistibly. We secured two poles, one about fifteen feet long, which we placed on the roof of the two story frame house in which I lived, and a somewhat longer one which we were allowed to erect on the roof of a barn some sixty feet distant. Between these poles we swung a 4-wire antenna of the flat-top type, not much different from those now in use. The wire was No. 18 annunciator; broomsticks served as spreaders, and the insulators were porcelain cleats. The lead-in ran into my mother's kitchen, and we obtained a ground on the water faucet. One

"...in sudden contact with the antenna"

afternoon in June the great experiment came to a climax. Our steel needle-pencil carbon detector was connected to the antenna and ground, in parallel with the battery and telephone. The latter was pressed to the ear with the hand; we had no headband. Tuning there was none. The combination was probably aperiodic, or nearly so, and would respond to a wide band of frequencies, given a signal strong enough. It worked as soon as it was put together. We had arranged to use the call "YF," and the first fellow to put the telephone to his ear heard the tripping Morse accents of the transmitting operator up on Prospect Avenue. A look of ineffable joy overspread the face of Lamont Whitney, who was the first, I believe, to listen at our end, and we knew he was hearing something. (He is now chief operator on the SS. *President Roosevelt*, and no doubt it takes more than a radio signal to make him happy now.) With reluctance he yielded the telephone receiver to me, and I heard the low-pitched, perfectly clear buzzing of the spark coil six blocks away. We took turns at listening all afternoon. In all, I believe, there were four of us. We also listened in the evening, but heard nothing. We left the apparatus connected and went to bed, I in my room not far from the lead-in, and the other boys to their homes.

The experience of the afternoon, and the proximity of the wireless receiver, excited me so that for some hours I did not sleep. Finally I drifted off. At about two o'clock in the morning I awoke with a sense of impending disaster. Something had frightened me. I sat up in bed, my heart thumping. It was a hot, sultry night. Suddenly I knew what it was. An ominous distant growling, followed by a crash, broke the stillness of the night. A lightning storm was approaching. I had a

vague notion that radio had something to do with lightning, and that it was the proper practice to ground the antenna when not in use. This we had neglected to do. Actually, of course, the risk was infinitesimal. The antenna might have been left ungrounded all through the thunderstorm, and nothing would have happened. I was not taking nearly as much risk as I did daily hitching on the back of ice-wagons, climbing trees, and fighting. But how was I to know this? I visualized the antenna on its long poles sticking up provocatively above the roof of the house, and all the time the storm was coming nearer, the lightning lit up the room with ghastly blue flashes, and the thunder began to shake the windows. It seemed to me that inevitably the lightning must hit that antenna and the house, with my father, mother, and sister, would all be incinerated. My teeth chattered; I was sick with fright. The thing to do, I realized, was to get up and ground the antenna before the storm came any nearer, but I was afraid to go near the lead-in. I was a boy of thirteen, in conflict with stupendous cosmic forces. I began to whimper. My parents, sleeping in the next room, had also been awakened by the storm, and they soon heard me. My father appeared in his nightshirt and demanded the cause of my tears. I informed him, sobbing, that the house was about to be struck by lightning. He immediately understood that there was some connection between the antenna and my fear of lightning a thing which had not occurred to him before, or probably he would not have permitted the erection of the antenna. The gas was lit, the whole family was aroused, and stood about quaking; my father was angry and denounced me as a young fool in tones which rivaled the thunder. This aroused my resolution. I leaped suddenly out of bed and charged across the hall to do or die. I grasped the antenna wire frantically—and nothing happened. I was not electrocuted, not even a spark leaped to my hand. Tearing the wire from its connection to the detector, I wrapped it around the water pipe, just before my father collared me and dragged me away from the set. The storm passed over and faded into the distance: with it, the alarm subsided, and my family went back to bed. My father lectured me at length the next day, but he allowed the antenna to remain up, having received assurances from other sources that it was not dangerous. But I was compelled to swing the lead-in from the kitchen down to a small storage house in the yard. And there, for reasons to appear, we had no further success in our wireless experiments.

I have recounted this hysterical scene, not only for the amusement of my readers, but to show what a part unreasoning fear plays in the psychology of people whenever they are faced by anything unknown. Since those days, millions of antennas have been erected and used without damage from lightning. They are no more dangerous than telephone or electric light service wires. For half a dollar one gets a lightning arrestor which supplies all the protection needed. But things were different in 1909. (*To be continued*).

I tore the wire off the detector

The Power of Broadcasting Stations

A NEW broadcasting station announces: "While rated at 1000 watts, the actual power attained when voice or music are in the air will reach a peak of 2500 watts." And so the press releases speak of the purchase of "a new 2500-watt . . . transmitter."

On that basis it would be just as reasonable to rate the set at 250 watts. For, each time that a 2500 watt peak is reached for $\frac{1}{1000}$ second or thereabouts, in the next $\frac{1}{1000}$ second the power will drop to about zero. The method of operation of the Heising system of modulation is that the modulating power is alter-

nately added to and subtracted from the carrier power. Thus the average or effective radiating power is that of the unmodulated carrier, and the carrier power is the proper rating of the station.

A corollary question which arises is: How much should the carrier be modulated? My own answer would be: 80 per cent. on the highest peaks. No higher, for if this figure is exceeded over-modulation will inevitably result at times. With a 20 per cent. margin, one can reduce accidental over-modulation so that it is very rare. Nor should the percentage of modulation be much below a maximum of 80 per cent., for two reasons. First, the loss in signal strength; secondly, the fact that in the receiving set the carrier amplifies any disturbances that may happen to be floating around, more or less in proportion to its amplitude, regardless of the modulation. If, therefore, a station has a strong carrier field at any point, weakly modulated, it is amplifying disturbances to the disadvantage of its own signal. The 80 per cent. figure steers a course between the devil and the deep sea.

Microphone Miscellany

THE MIRACULOUS MR. BURROWS

ITEM from the New York *Times* of May 8th:

> Geneva, May 7 (A. P.)—Broadcasting by private European companies will be regulated from Geneva, with the arrival here to-day of Arthur Burrows, an Englishman, who has been appointed mediator for all broadcasting companies.
>
> His special mission is to prevent the clashing of wavelengths and consequent interference of aerial concerts with each other. Geneva was chosen for the base of operations because of its steady growth as an international centre and its central geographical position.
>
> Burrows expects to produce order out of the chaos that has disturbed European listeners-in.

This is delightful indeed. Here we are breaking our heads over this situation, and a solution is ready at hand. If Mr. Burrows can perform as predicted, we propose that he be invited to the United States and, the constitutional inhibition on a foreign-born president being waived, he may be voted to that office by acclamation. He can then proceed to iron out the new stations-no wavelengths problem which has our Department of Commerce so worried, and he will rank among Presidents with George Washington and Abraham Lincoln.

I took the child from the "mike"

THE EPIC OF THE LITTLE CHILD

HASTILY written report of a field operator at WJZ in explanation of noise interference at the beginning of a hotel music program:

> At the beginning of the first number a little child got to rattling the mic. stand and pulling the mic. cord and I not being able to see it I didn't know what the matter was but was put on the air again and I discovered the trouble and cleared the trouble by taking the child away from the mic.

Brutal field operator! We hope the child's mother broke a soup tureen over the operator's head.

Who Will Lay It? A gentleman wrote to a broadcasting station inquiring whether any one had thought of using a submarine cable to bring broadcast material from Europe to the United States, thence to be re-broadcast from American stations. Some harassed member of the technical staff answered that the idea was not feasible, for the electrical characteristics of existing types of long cables were such that they would not transmit the rapid variations of speech and music. Rebuttal was as follows:

> You say the Atlantic cable cannot be used to transmit. Well, let us lay a Radio Cable some concern with money or the Government.

Who are we to say that it can't be done? Maybe it can. We will need $2,500,000 for research. Another $5,000,000 will cover the manufacture and laying of the new marvel of science. Total, $7,500,000. Will some philanthropist with that much money incommoding him please remit as soon as convenient?

An Induction Loud Speaker

The Acoustical and Electrical Characteristics of a Loud Speaker Capable of Handling Large Amounts of Energy and which Produces Sounds of Tremendous Volume with Negligible Distortion—The Mathematics of Its Design

By C. W. HEWLETT

Research Laboratory, General Electric Company

THE loud speaker described in this paper cannot be used for the purposes of the ordinary broadcast listener, but it is an electrical device of extraordinary interest. Because it can handle such large quantities of power and reproduce voice and music with such unusual faithfulness, this device has attracted a great deal of attention. This paper was delivered before a recent meeting of the Radio Club of America, in New York City and is full of the theory and mathematics of design, but it is an interesting and complete presentation of an excellent piece of work.—The Editor

THE problem of reproducing speech and music by electrical means may be arbitrarily divided into four main parts. The first of these concerns the operation, known technically as "pick up." In this operation, the sounds to be reproduced are allowed to produce electrical effects which are usually quite small. The second part of the problem concerns the amplification of the small electrical effects produced by the original sound waves. The third part of the problem concerns the transmission of the electrical signals from one place to another. This usually occurs between the stages of amplification. The fourth part of the problem is that of reproducing sound waves by means of the amplified electrical effects. In case the transmission is accomplished by electrical waves in space, there is still another part of the problem, namely, that of receiving the signals. This may, however, be included in the division of the problem concerning amplification, because many of the considerations involved in radio reception are of a similar nature to those involved in amplification.

This discussion will concern itself mainly with the fourth part of the problem as outlined above; namely the reproduction of speech and music by operating by electrical means upon a particular type of "loud speaker."

The loud speaker, which I shall describe and discuss, is known as the "Induction Loud Speaker," and has already been described in its essential features in previous publications (*Phys. Rev. 17*, p. 257, 1921 and *19*, p. 52, 1922. *Jr. Opt. Soc. Am. 4*, p. 1059, 1922). For the sake of completeness I shall repeat here a brief description of the construction and principle of operation of the instrument.

ESSENTIALS OF THE SPEAKER

THE induction loud speaker consists of two flat circular coils mounted coaxially on either side of a circular sheet of metal such as aluminum. Fig. 1 shows a picture of the parts, and Fig. 2 several models of the assembled instrument. Each coil is made up of sections with annular air spaces between them. These sections are secured to the wooden framework by means of wires which pass around them and through holes in the spider. The sections are connected in series and the terminals of each coil are brought out to two binding posts fixed to the circular frame. The circular diaphragm of aluminum has the same diameter as that of the circular framework. It is lightly held between the two frames by small pieces of felt placed between the diaphragm and each frame at intervals of about 3 inches around its circumference. This method of support leaves the diaphragm quite free to vibrate through such amplitudes as are required of it and allows it to expand when it gets hot. It also allows a certain amount of convection of air to pass upward between the coils and diaphragm and out at the top between the frames and diaphragm. The two coils shown in Fig. 1 are 25 inches in diameter, have an axial width of about $\frac{1}{2}$ inch and contain about 75 pounds of 45 mil wire. The frames and diaphragm are 30 inches in diameter. When mounted the coils are about $\frac{1}{4}$ inch from the aluminum diaphragm, whose thickness is 10 mils.

In operation the instrument is connected as shown in Fig. 3.

The generator sends a direct current through the coils which are connected so that the two magnetic fields due to this current oppose one another. The resultant magnetic field in the space occupied by the diaphragm lies along the radii of the diaphragm. The by-pass condensers C C enable the voice current from the amplifier to pass through the two coils in multiple. From the standpoint of the voice currents, the instrument is an alternating current transformer, the two coils being the primary and the aluminum diaphragm a one-turn secondary. The alternating current in the diaphragm distributes

itself throughout the whole diaphragm, and the flow lines are circles concentric with the axis of the diaphragm, and consequently are at right angles to the radius of the diaphragm at all points. The magnetic field, due to the direct current, and the induced voice currents in the diaphragm, are therefore at right angles at all points, and the diaphragm experiences an electrodynamic force of the same character as the wave form of the voice current. This force is distributed fairly uniformly over the whole of the diaphragm, and to a high degree of approximation, the phase of the force is the same at all points, at least for the range of frequencies concerned in the reproduction of speech and music.

CHARACTERISTICS OF THE SPEAKER

THIS instrument reproduces speech and music with remarkable faithfulness, but its sensitiveness is much below that of the more usual types of sound reproducing devices. On account of its size and ruggedness, however, it may be supplied with large amounts of power, so that an enormous volume of sound may be produced. In fact, the device readily lends itself to the field of public address where thousands of people are to be reached in large auditoriums, or even out of doors.

This instrument embodies several features which are obviously of great importance for the faithful reproduction of speech and music. In the first place, the diaphragm is aperiodic which, while contributing to the instrument's lack of sensitiveness, eliminates all distortion due to resonance. In the second place, the force moving the diaphragm is distributed fairly uniformly over its whole surface so that the diaphragm moves as a whole, there being no tendency for it to vibrate in segments, which might result in resonance at frequencies corresponding to its partial vibrations. Thirdly, the large area of the diaphragm results in relatively efficient radiation over the lower range of frequencies, without the use of a horn. In speech and many forms of music most of the sound energy is carried by the lower frequency components, while the naturalness of speech is lost if these lower frequencies are not present in sufficient quantity. In the fourth place, the instrument is simple and rugged in construction and does not require any fine adjustments. When once put into operating condition it will remain so indefinitely.

OPERATION OF A LARGE DIAPHRAGM

IN ORDER to make some calculations of what we should expect in the performance of a large area diaphragm, we shall make certain simplifying

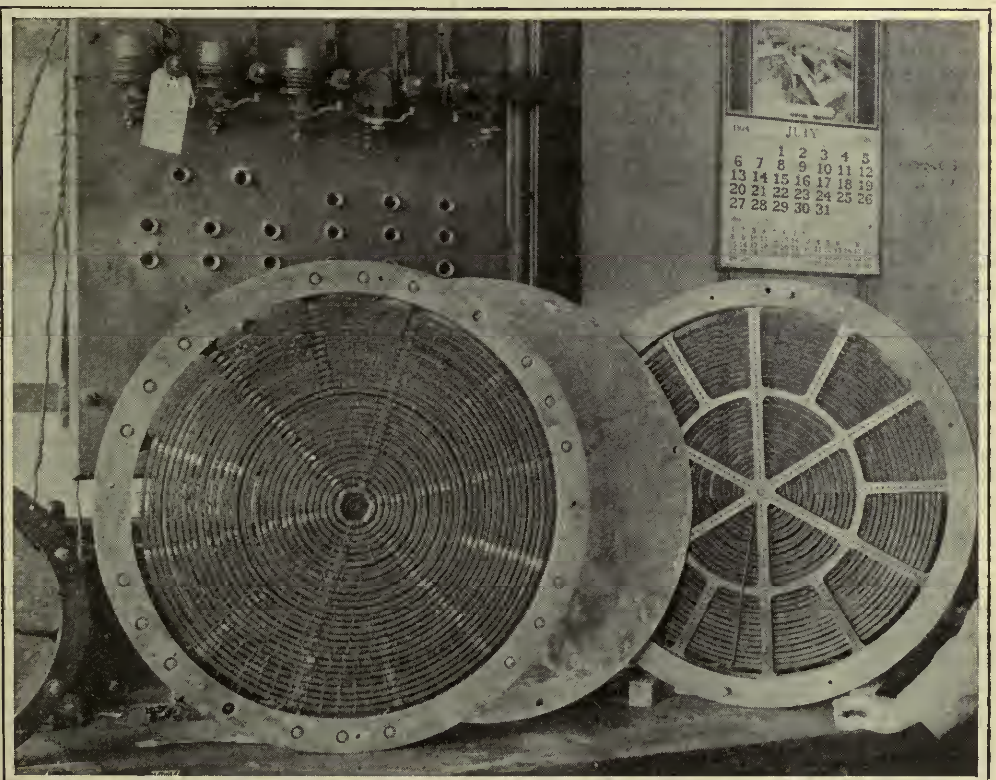


FIG. 1
Several of the Hewlitt Induction loud speakers in a corner of the research laboratory of the General Electric Company at Schenectady

assumptions in regard to the boundary conditions in the surrounding medium, and in regard to the driving forces acting on the diaphragm.

In the first place, we shall assume that the diaphragm moves as a whole when vibrating. The degree to which this is realized in practice depends upon the distribution and phases of the electrodynamic forces over the diaphragm; upon the natural periods of vibration in which the diaphragm may vibrate owing to its elastic properties; and upon the manner in which it is supported. The polarizing field, which is radial, is weak near the center, but fairly uniform over the major portion of the diaphragm. The magnitude of this component of the field in gauss is very roughly given by the total ampere-turns on both sides of the diaphragm divided by the diameter of the diaphragm. The induced current in the diaphragm should be most densely distributed in the central portion of the diaphragm where the radial field is the weakest. Since the electrodynamic force acting on the diaphragm is proportional to the product of the radial field and the current induced in the diaphragm, it would seem that to a first degree of approximation we would be justified in assuming that the force is uniformly distributed over the diaphragm. This assumption neglects whatever phase difference exist between the induced currents in the different parts of the diaphragm.

In regard to resonant periods the diaphragm is so large, and so loosely held between the edges of the supporting framework, that the fundamental period would be only a few cycles per second. Moreover the restoring force is so small, and the dissipation so great on account of the looseness with which the diaphragm is held, that the partial vibrations would not arise with appreciable intensity. The fact that the diaphragm is held around the edges should not affect its motion very far from the edge, for the maximum amplitudes of motion under ordinary conditions of use would not exceed 1 mm. for frequencies as low as 30 cycles, and for higher frequencies, the amplitude falls off almost as fast as the inverse square of the frequency. Actual listening tests have shown that the quality of speech or music produced by a large diaphragm, say 2 feet in diameter, suspended by two strings cannot be distinguished from that produced by one clamped around the edges.

INTENSITY OF SOUND WAVES FROM A LARGE DIAPHRAGM

WE SHALL also assume that the diaphragm is bounded by an infinite plane which is at rest, and that the medium extends indefinitely in all directions on both sides of the plane. In actual practice, the instrument is not bounded by a large plane. This assumption introduces very little error into the calculations we shall make for waves short compared to the circumference of the diaphragm, but when the length of the waves becomes comparable to the circumference of the diaphragm, the calculation will give too great radiation, and the error will be greater, the longer the waves.

The problem of calculating the intensity of the sound waves given off from a vibrating diaphragm under the conditions as we have limited them has been solved by Lord Rayleigh. (*Theory of Sound*, Vol. II, p. 162–169).

The equation of motion for a simple harmonic application of force is

$$m \frac{d^2x}{dt^2} + k \frac{dx}{dt} + n^2x = F \cos \omega t$$

where x is the displacement of the diaphragm from its position of equilibrium, F is the maximum value of the harmonic force impressed on the diaphragm, $\omega = 2\pi$ times the frequency, n^2 is the elastic force opposing displacement for unit displacement,

$$m = m_o + \frac{\pi\rho}{2\,a^3} K, (2\,a\,R)$$

$$\text{Where } K_1(z) = \frac{Z}{\pi}\left(\frac{Z^3}{1^2.3} - \frac{Z^5}{1^2.3^2.5} + \frac{Z^7}{1^2.3^2 5^2.7} - \text{etc.}\right)$$

and m_o is the mass of the diaphragm, ρ is the density of the air, $a = \frac{2\pi}{\lambda}$, λ is the wave length of the air vibration set up by the diaphragm, R is the radius of the diaphragm.

$$k = v\,\rho\,\pi\,R^2\left(1 - \frac{J_1(2\,a\,R)}{a\,R}\right)$$

$J_1(z)$ is the Bessell function of the 1st order of z, and v is the velocity of sound.

In the case under discussion, the diaphragm vibrates across a radial magnetic field, so that there is a magnetic damping force acting on the diaphragm in addition to that due to the emission of sound waves. The approximate calculation of this effect is given in appendix I and is shown to consist of two force terms, one multiplying the displacement, and the other the velocity. Both terms are shown to be negligible compared to the other terms present.

The force driving the diaphragm arises from the interaction of the radial magnetic field and the currents induced in the diaphragm by those in the coils. In appendix II, the approximate magnitude of this force is calculated and shown to be

$$F = H\sqrt{\frac{2\,W_o A}{r}}$$

where H is the strength of the radial magnetic field, W_o is the audio power transferred from the coils to the diaphragm, r is the superficial resistivity of the diaphragm and A is its area. The square of the force acting on the diaphragm is thus proportional to its area for definite values of H, W_o, and r.

Returning to the equation of motion of the diaphragm we may calculate the power expended by the driving force F cos ωt.

$$\text{This is } W = \frac{\omega}{2\pi}\int_o^{\frac{2\pi}{\omega}}\left[m\frac{d^2x}{dt^2} + k\frac{dx}{dt} + n^2x\right]\frac{dx}{dt}\cdot dt$$

$$= \frac{k\,F^2}{2\left(k^2 + \left[\frac{n^2 - \omega^2 m}{\omega}\right]^2\right)}$$

Estimation of n^2 for the diaphragm under consideration shows it to be entirely negligible compared to

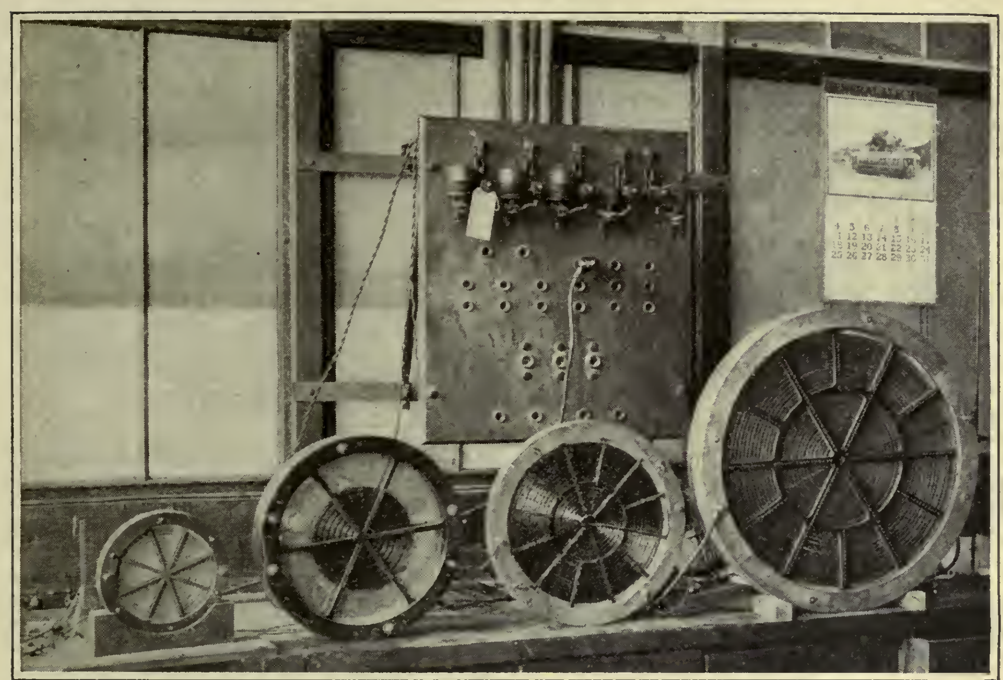


FIG. 2
Various size models of the induction loud speaker

$\omega^2 m$ for all frequencies with which we are concerned. The sound energy radiated each second then becomes

$$W = \frac{k F^2}{2 (K^2 + \omega^2 m^2)}$$

For very short waves this is radiated almost as a beam of plane waves of cross section equal to that of the diaphragm. As the waves get longer, the beam spreads out, and when the length of the waves is comparable to the circumference of the diaphragm the radiation passes out in all directions, and at the same time the above expression for W gives too large a value for the total radiation, because the diaphragm is not bounded by an infinite plane at rest. If a sound measuring device were placed in front of the vibrating diaphragm, and its indications taken for a wide range of frequencies, these indications would be proportional to W, calculated from the above expression, only for wavelengths short compared to the circumference of the diaphragm. For increasing wavelengths comparable to and larger than the circumference, the indications of the measuring instrument would increase less rapidly than W calculated from the above expression for two reasons. First, because on account of the greater spreading for long wavelengths a less proportion of the energy radiated would enter the measuring instrument, and second, because the expression gives too great a value for the radiation at long wavelengths. This consideration should be borne in mind when examining the tables and curves to follow showing the sound energy radiated from the diaphragms as a function of the frequency.

CALCULATION OF SOUND RADIATION

THE sound radiation will be calculated for several different sizes of diaphragms. In order to make the results comparable, we shall assume that the radial magnetic field has the same strength for all sizes of diaphragm. As is shown in appendix III, this corresponds approximately to dissipating an amount of direct current power proportional to the square of the diameter of the instrument. We shall also assume that the same amount of voice-current power will be supplied to all sizes of instrument, that is, we shall employ the full output of a given audio amplifier to drive all instruments. As has been shown, this means that the force actuating the diaphragm is proportional to its radius. A comparison of the results so obtained will favor the smaller instruments from the standpoint of *total sound output*, for the radial field may be made stronger at a constant temperature of operation, and more audio power may be safely supplied to the larger than to the smaller instruments. With the same limiting temperature of operation the field of the largest instrument discussed might be from one to two times as great as that of the smallest, while the audio power input might be from ten to twenty times as great, so that the total sound energy output might be twenty to forty times as great in the case of the largest instrument. For any one instrument, however, these considerations would

not affect the relative amount of sound energy output at different frequencies. It might be remarked at this point that as the sound energy output is proportional to the product of the strength of the polarizing field, and the audio current in the diaphragm, and as the total power supplied is limited by the allowable temperature rise, the sound energy output is a maximum when the two powers are equal (see appendix IV). But owing to the great disparity in the cost of polarizing and audio power it is advisable to use polarizing power to within a small percentage of the allowable dissipation. For example, using the 25-inch instrument with 800 watts of polarizing power, and 30 watts of audio power, the sound pressure output is about 15 per cent. of what it would be using 415 watts of each kind of power.

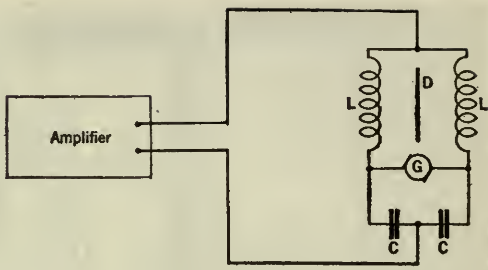


FIG. 3
The circuit diagram of the Hewlitt induction loud speaker. L L are the two flat coils; D, the aluminum diaphragm; G, a direct current generator; and C C, by-pass condensers

VALUES OF DIFFERENT DIAPHRAGMS

THE calculation has been carried out for five different sizes of diaphragm assuming a uniform field strength H=300 gauss, and that the audio power input is 1 watt in each case.

The diaphragms are all of aluminum .025 cm. thick. The following table gives the results of the calculations and these are represented graphically in Fig. 4.

TABLE I

Radius	$\frac{30}{\pi}$ cm.	$\frac{60}{\pi}$ cm.	$\frac{100}{\pi}$ cm.	$\frac{150}{\pi}$ cm.	$\frac{300}{\pi}$ cm.
Frequency cycles/sec.	W in Kiloergs per sec.				
30		8.81	16.5	26.9	53.4
60	2.85	8.05	16.6	27.4	55.0
100	2.55	7.91	16.5	27.1	57.1
150	2.46	8.40	16.2	26.2	50.6
200	2.51	7.63	15.1	25.1	31.0
300	2.48	7.22	13.5	17.2	16.9
400	2.28	6.23	9.61	8.69	9.3
600	2.18	4.65	4.23	4.69	6.9
750	1.96	3.13	2.83		
1000	1.61	1.56	1.68		
1500	0.80	0.78			
2000	0.39				
3000	0.18				

As already stated, it should be borne in mind that the actual frequency characteristic as perceived by one standing in front of the instrument would not be so pronounced as indicated by the table and curves, because the calculation gives too great a value for the radiation at low frequencies, and also the lower the frequency the more the spreading of the sound. Moreover the response of the ear mechanism is proportional to the sound wave pressure rather than to the energy flux. At any given frequency the sound wave pressure is proportional to the square root of the energy flux. Still another consideration is the relation between the impedance of the amplifier and that of the loud speaker. Fig. 5 shows the impedance-frequency curve for the 25-inch or $R = \frac{100}{\pi}$ cm. instrument, provided with an aluminum diaphragm .025 cm. thick. The by-pass condensers shown in Fig. 3 were 3 mfd. each. It is apparent that if the power amplifier has an impedance of 1000 ohms, then the power delivered to the loud speaker is going to fall off rapidly below a frequency of 600 cycles, which will prevent the excessive radiation of low frequencies. In fact, quite noticeable changes in the general pitch level of the reproduced speech of music can be accomplished by adjusting the impedance of the loud speaker by means of transformers. The difference in the directivity of the loud speaker for short and long waves is shown by the progressive loss in articulation, particularly with the larger instruments, as the angle between the axis of the instrument and a line drawn from the instrument to the observer is increased. When using the larger instruments out of doors and in auditoriums it is well to use at least two in order to so direct them as to minimize the effect just mentioned.

QUALITY OF THE SPEAKER ON LOW FREQUENCIES

IN ORDER to arrive at some idea as to how great an error is made in assuming for the purposes of calculation that the diaphragm is bounded by an infinite plane at rest, a large board, 6 feet square, was prepared with a circular hole of variable diameter in the center into which various size instruments could be placed. It was found with the smallest instrument, $R = \frac{30}{\pi}$ cm., the general pitch level of speech and music was noticeably lowered when placed in the hole in the board, while with the instrument $R = \frac{100}{\pi}$ cm. this lowering of the general pitch level was barely noticeable. This means that, for the range of frequencies with which we are ordinarily concerned in the reproduction of speech and music, the failure of the expression for W at low frequencies is of little importance. Of course, there is still left the effect of the greater spreading of the lower frequencies.

On the whole, after taking everything into consideration, it appears that the instrument ought to reproduce well the lower frequencies which is necessary for naturalness in the reproduction of the human voice and for richness of quality in music. It is seen that the smaller diaphragms should give a fairly flat frequency characteristic over a greater

range than do the larger ones. That is, the higher tones should be relatively more important in the smaller than in the larger instruments. These conclusions are borne out by experience.

APPENDIX I

WE SHALL only attempt to get a rough estimate of the order of magnitude of the magnetic damping force acting on the diaphragm owing to its vibration across the radial magnetic field. For this purpose let us suppose that the metal composing the diaphragm is concentrated into a single circular turn of wire of circular cross section whose diameter is one half that of the diaphragm. Let this ring vibrate parallel to its axis with displacement x, velocity v and amplitude A. Then $x = A \sin \omega t$ and $v = \omega A \cos \omega t$. The induced electromotive force is $e = v\,c\,H$, where c is the circumference of the circular wire and H is the strength of the radial magnetic field. Then

$$e = \omega A\,c\,H \cos \omega t$$
$$= E \cos \omega t, \text{ where } E = \omega A\,c\,H$$

Applying Kirchoff's law, letting i be the induced current

$$i\,r + L\frac{di}{dt} = E \cos \omega t$$

where r and L are the resistance and inductance of the wire. From this follows

$$i = \frac{E}{\sqrt{r^2 + (\omega L)^2}} \cos (\omega t - \theta) \text{ where } \tan \theta = \frac{\omega L}{r}$$

The reaction of the field on this current is

$$f = i\,c\,H = \frac{\omega A}{Z} (C\,H)^2 \cos (\omega t - \theta)$$

$$\text{where } Z = \sqrt{r^2 + (\omega L)^2}$$

or

$$f = \frac{\omega A\,(C\,H)^2}{Z^2} \left[r \cos \omega t + \omega L \sin \omega t \right]$$
$$= r \left(\frac{C\,H}{Z}\right)^2 \cdot \frac{dx}{dt} + \omega^2 L \left(\frac{C\,H}{Z}\right)^2 \cdot x$$

In order to take account of this force, we may assume that this is the magnetic drag that would act on the diaphragm represented by the ring, and we may then add the above coefficients of $\frac{dx}{dt}$ and X to the corresponding coefficients in the original equation of motion. To carry this out for a particular case, the instrument $R = \frac{100}{\pi}$ cm. with an aluminum diaphragm .025 cm. thick was chosen. It is assumed that H = 300 gauss; calculation of the other quantities concerned give

$$r = 3.52 \times 10^5 \text{ e.m.u.}$$
$$L = 7.41 \times 10^2 \quad ''$$
$$C\,H = 2.95 \times 10^4 \quad ''$$

If we let $a = r \left(\frac{C\,H}{Z}\right)^2$

$$\frac{b}{\omega} = \omega L \left(\frac{C\,H}{Z}\right)^2$$

then the expression for the sound energy radiated is

$$W = \frac{k\,F^2}{2\left[(k + a)^2 + \left(\frac{b}{\omega} - \omega m\right)^2\right]}$$

The radiation in kiloergs /sec. and the amplitude in cm. calculated for this instrument for an input of 1 watt of audio power is given in table II.

TABLE II

FREQUENCY CYCLES /SEC.	W KILOERGS /SEC.	A CM.
30	16.9	1960×10^{-5}
60	16.9	500 "
150	16.7	85 "
300	13.5	24 "
600	4.2	7 "

From a comparison of the values of W in Table II with those for the same instrument in Table I it is apparent that the damping of the magnetic field has no appreciable effect on the frequency-radiation characteristic of the loud speaker.

APPENDIX II

IN ORDER to get an approximate idea of the periodic force driving the diaphragm, let us assume that the audio power is transferred quantitatively to the diaphragm, and is there dissipated in heat. The audio impedance with diaphragm is only a few per cent. of that without diaphragm, and it is seen from Table I that with a field strength of 300 gauss somewhat less than 0.2 per cent. of the audio power is converted into sound radiation. The above assumption is, therefore, justified for a first approximation. We shall also assume that the induced current in the diaphragm is uniformly distributed. Let I be the maximum value of a sine wave audio current through an annulus of the diaphragm, 1 cm. wide, and let *r* be the superficial resistivity of the diaphragm. Let A be the area of the diaphragm, and W_o the audio power supplied. Then $I^2\,r\,A = 2\,W_o$, and the maximum value of the force on the diaphragm is $H\,I\,A = H\sqrt{\frac{2\,W_o\,A}{r}}$ where H is the strength of the radial magnetic field. For a given thickness of diaphragm of a given material, a given field strength, and a definite supply of audio power, the square of the force driving the diaphragm is proportional to the area of the diaphragm.

APPENDIX III

THE power dissipated in the instrument has to be eliminated through the faces of the coils, and in the absence of forced ventilation, the amount of power that can be dissipated from instruments of various size with a given mean temperature rise of the coils will be proportional to the area of the coils. The induction loud speakers have been designed to operate at a temperature of 100° C. The power to be dissipated is practically the polarizing power, since the audio power under actual conditions of operation is only a few per cent. of the

polarizing power. The following brief analysis will show the relation between the polarizing voltage, the number of turns, and the linear dimensions of the coils:

Let R = radius of one pancake coil
r = resistance one pancake coil
t = axial depth of winding
n = number of turns in one pancake
E = voltage on one pancake
S = space factor of windings
ρ = specific resistance of the wire.

Let us assume a constant space factor for coil windings when using wire of various sizes, and for various size coils. This factor may vary from 0.40 to 0.50, and takes account of the thickness of insulation, the circular section of the wire, and the space between sections for the passage of sound waves.

$$\text{Then } r = \frac{\pi R n \rho}{\frac{R t s}{n}} = \frac{\pi \rho}{S} \cdot \frac{n^2}{t} = K_1 \frac{n^2}{t} \qquad (1)$$

For the 25-inch instrument described in this paper, K_1 has a value of 1.31×10^{-5} at 20° C with r measured in ohms, and t in cm. This is a good representative value for K_1 and corresponds to a space factor of 0.426 and a specific resistivity of 1.78×10^{-6} ohms per cm^3.

Equation (1) shows that the resistance of a pancake can be expressed in terms of the number of turns of wire and the axial thickness of the winding, independent of the diameter of the instrument.

The power dissipated in one pancake coil is $\frac{E^2}{r} = \frac{E^2 t}{K_1 n^2}$. Let us suppose this proportional to the exposed area of the pancake coil. Then

$$\frac{E^2 t}{K_1 n^2} = K_2 R^2$$

When both pancakes are mounted together as they are in the assembled instrument, it is found that a temperature rise of 80° C corresponds to a value of $K_2 = 0.50$ when R is measured in cm., and the power in watts. $K_2 R^2$ then gives the power dissipated as heat in each pancake coil.

Solving the last equation for n we have

$$n = \frac{E}{R}\sqrt{\frac{t}{K_1 K^2}} \qquad (2)$$

that is for a given operating voltage, the number of turns is proportional to $\frac{\sqrt{t}}{R}$. The current is $i = \frac{E}{r} = \frac{Et}{K_1 n^2}$

The ampere-turns for one pancake coil are $ni = \frac{Et}{K_1 n}$

and by Ampere's law, the strength of the radial component of the magnetic field contributed by one pancake is approximately proportional to $\frac{ni}{R} = \frac{Et.}{K_1 n R}$

Let us see what condition must be fulfilled in order that we may have the same strength of magnetic field for instruments of all sizes, that is

$$\frac{Et}{K_1 n R} = K_3 \qquad (3)$$

If E is expressed in volts, and the other quantities expressed as previously specified, then K_3 is approximately 1.6 times the strength of the radial component of the magnetic field due to one pancake, or 0.8 times the total radial component when both pancakes are present, the strength of the magnetic field being expressed in gauss.

Eliminating $\frac{E}{Rn}$ from (2) and (3) we have $t = \frac{K_1 K_3^2}{K_2}$

or the axial thickness of all the coils must be the same. Actually, the demands on the instrument from the standpoint of an audio transformer are such that the thickness of the coils may be made larger in the larger instruments than in the smaller ones. Therefore, with the larger instruments we may have a stronger radial magnetic field than with the smaller ones when operating at the same temperature.

In order to design the windings for an induction loud speaker, the following procedure will be found to be as direct as any. Suppose the approximate radius, R, of the pancake coils ,and E, half the polarizing voltage, are given. First choose t, the axial thickness of the pancake, which may be 0.5 inches for coils as small as 4.5 in. radius to 1.0 inch for coils as large as 18 in. radius. Choose next, a space factor between 0.40 and 0.50. Calculate K. and take $K_2 = 0.50$. Then $H = \frac{K_3}{0.8} = 1.25\sqrt{\frac{K_2 t}{K_1}}$

which should be at least as large as 280 e.m.u. If H is not this large, t or s should be adjusted

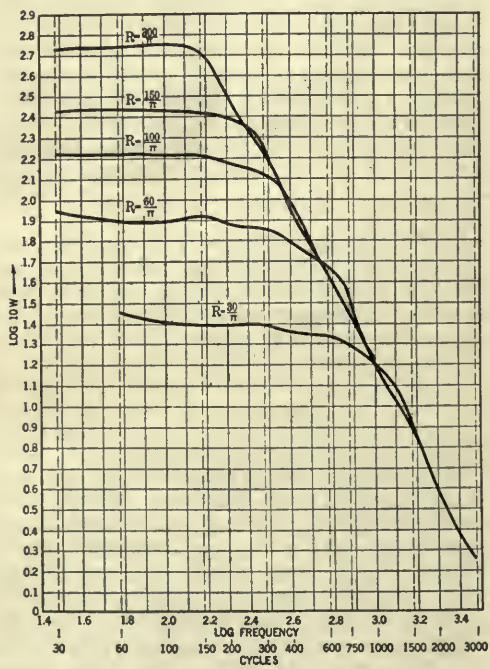


FIG. 4

accordingly. The resistance of the pancake coil is given by $\frac{E^2}{K_2R^2}$. If d is the density of copper $\pi R^2 t$ Sd gives the mass of copper in the pancake, and from this and the resistance, the size of wire to be used may be read off from a wire table. The number of turns may be calculated from equation (1). Using the above figures as approximations, the coil may now be accurately designed by obvious procedure. If the polarizing voltage is very low, say less than 100 volts, the instrument may require excessive current, and be of very low impedance, while if the voltage is high, the reverse conditions may be encountered. 250 to 500 volts for polarizing have been found to give very satisfactory results, both from the standpoint of polarizing current and audio impedance for all sizes of instruments so far built.

APPENDIX IV

LET us determine the condition for the maximum amount of sound radiation output for a given total amount of polarizing and audio power input. The force driving the diaphragm is directly proportional to the strength of the radial magnetic field, which in turn is directly proportional to the polarizing current i_1. The force is also proportional to the audio current in the diaphragm, which in turn is proportional to the audio current in the coils i_2. The sound pressure output p is proportional to the force acting on the diaphragm and, therefore, we may write

$$p = K_1 i_1 i_2 \qquad (1)$$

If r_1 and r_2 are the d-c and audio resistances, respectively, of the instrument, then the condition that the total power supplied shall be independent of the relative proportions of polarizing and audio powers, is

$$i_1{}^2 r_1 + i_2{}^2 r_2 = K_2 \qquad (2)$$

differentiating (1) and (2) with respect to i_1, we have

$$\frac{dp}{di_1} = K_1 i_2 + K_1 i_1 \frac{di_2}{di_1} \qquad (3)$$

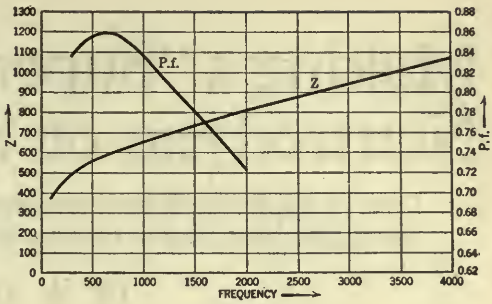


FIG. 5

$$2i_2 \frac{di_2}{di_1} r_2 + 2i_1 r_1 = 0 \qquad (4)$$

From (4) we have $\frac{di_2}{di_1} = -\frac{i_1}{i_2} \cdot \frac{r_1}{r_2}$ (5)

Substituting (5) in (3) and equating to 0, we have $i_2{}^2 r_2 = i_1{}^2 r_1$, which is the condition that p shall be a maximum. It therefore follows that the audio and polarizing powers should be equal in order that the maximum sound radiation should be produced.

Acknowledgements

The writer wishes to gratefully acknowledge the helpful interest shown by Dr. W. R. Whitney throughout the development of this instrument. His ever present encouragement and faith is largely responsible for the successful outcome of this work. I wish also to take this opportunity to express my appreciation of many helpful suggestions from my colleagues Messrs. E. W. Kellogg, E. P. Lawsing, and C. W. Rice. The instrument described in this paper was invented in 1919 while the writer was teaching at the University of Iowa, Iowa City, Iowa. Its development described in this paper was carried out in the Research Laboratory of The General Electric Company, Schenectady, New York.

Neutralizing and Tuned Radio Frequency

ANOTHER paper presented before the Radio Club of America will appear in Radio Broadcast for September. It is by C. L. Farrand and deals with his further findings in the field of tuned radio frequency amplification, especially in the important matter of neutralization. The progress of Mr. Farrand's experiments is traced and diagrams and photographs show clearly his research in this very important subject.—The Editor.

Making a "Super-Het" From Your Neutrodyne or Single-Circuit Set

How to Apply the Frequency-Changer to Two Very Popular Types of Receivers, Resulting in Greater Receiving Range and Sharper Tuning

By A. O'CONNOR

¶ *RADIO constructors and radio operators everywhere have long been interested in some method which would permit them to add a device to their set which would make it into a super-heterodyne. That receiver still stands as one of the most sensitive and desirable from many points of view. In* RADIO BROADCAST *for June, Mr. O'Connor described the details of construction of the Frequency-Changer developed by him, and in this article, his very clear instructions tell just how it may be applied to a single-circuit or a neutrodyne receiver. The first article aroused a great deal of interest, and we feel sure that this one will appeal to a great number of broadcast listeners who want the well known benefits of super-heterodyne reception.*—THE EDITOR

THE ambition of many owners of receiving sets to own a super-heterodyne has been deterred for several reasons, chief of them being the high cost and because the owner of an already existant receiver did not feel like disposing of it at a sacrifice. In RADIO BROADCAST for June the writer described a simple one-tube Frequency Changer that could be added to any receiver, thereby converting it to a most efficient and inexpensive super-heterodyne. And after constructing such a unit, the first thought in the builder's mind must be the question of applying it to the receiver he owns.

Perhaps the simplest place to utilize this Frequency-Changer is in connection with the simplest known receiver, the single-circuit "blooper." This type of receiver being, probably, more generally owned than any of the others, it seems logical to show the tricks that must be performed with the blooper before it is a "super."

Briefly, the Frequency-Changer is a device for heterodyning incoming signals and passing them on to the intermediate-frequency amplifier at a greatly changed frequency. The intermediate amplifier consists of the present receiver, and the changing of frequencies takes place in the unit described in this magazine for June.

As stated in the first article of the series, the unit will increase the volume of signals, will enable any receiver to reach out to greater distances, will add greatly to the selectivity of the existing receiver, and will be an aid toward preventing radiation. Due to the fact that the beat frequency generated in this unit is very high, compared to the usual super-heterodyne, stations will appear only once on the tuning dials, an advantage that will appeal to all those who like ease of tuning.

ADVANTAGES OF THE FREQUENCY-CHANGER

ANOTHER advantage of this addition to any receiver lies in the fact that all tuning is done on the Frequency-Changer, and none on the receiver. This feature is particularly important to users of neutrodynes and the more complicated four- and five-tube receivers, for with the addition of the unit, tuning controls have been reduced to two. The dial numbers will be essentially alike at all broadcasting frequencies, and may be calibrated.

Fig. 1 is a schematic diagram of the Frequency-Changer, and Fig. 2 is a photograph of the completed unit, both illustrating the simplicity of the device. Fig. 3 represents the more usual types of single-circuit receivers, and the methods of attaching the Frequency-Changer unit to them.

There is only one difficulty in connecting the unit to such receivers, and that lies in the fact that it is possible to short-circuit the 45-volt B battery which is connected in the output of the unit. This can be prevented by simple precautions. The grid circuit of some types of this regenerative receiver is connected to the negative B and since the Frequency-Changer is connected to plus B there is the possibility of short-circuiting the B battery.

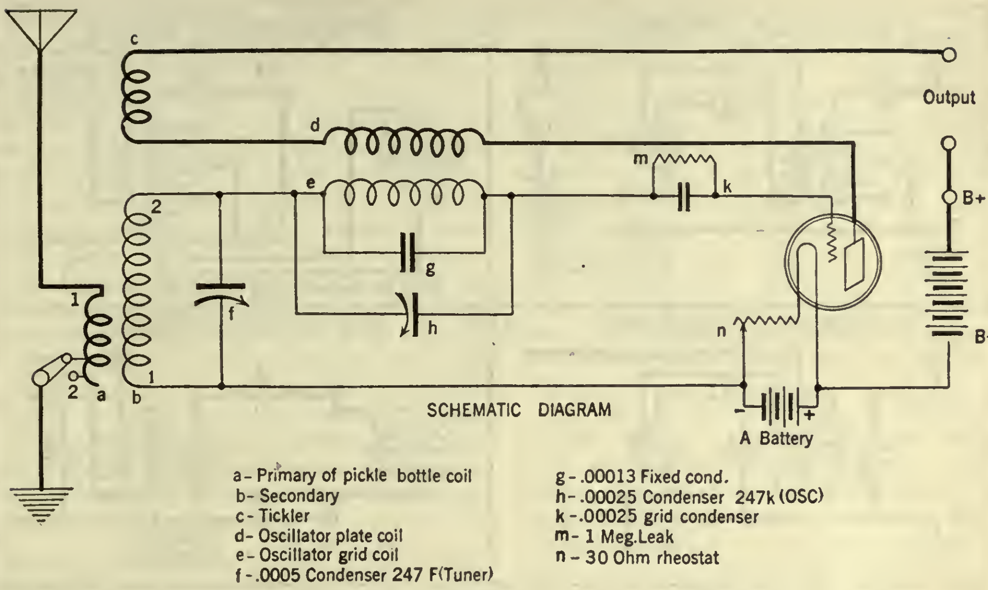


FIG. 1

The Frequency-Changer unit that may be added to any receiver to make it into a super-heterodyne

This is illustrated A and in B of Fig. 3 and the method of avoiding trouble is shown. In A, the method consists of winding a small coupling coil of 6 turns of No. 20 double silk covered wire around the grid coil of the receiver and insulating the two windings by a layer of empire cloth or tape. The antenna and ground connections are then connected together. In B, the method is simpler, since it is only necessary to cut the connecting wire between the small primary coil and the secondary winding.

The matter of selection of the type of tube is not highly important, since any of the standard

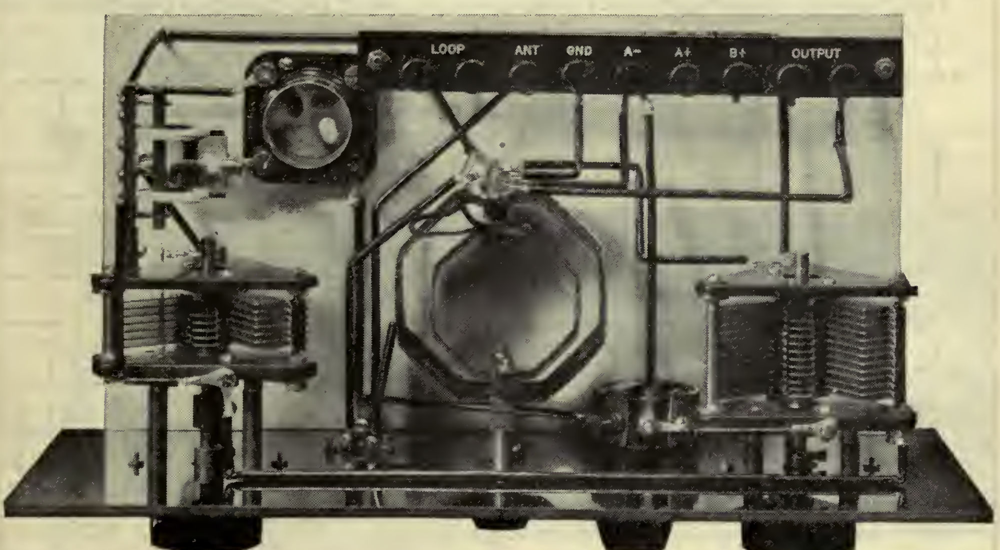


FIG. 2

The disposition of the parts and the simplicity of the wiring may be seen from this photograph which looks down upon the Frequency-Changer. How to build this unit was described in Radio Broadcast for June, 1925

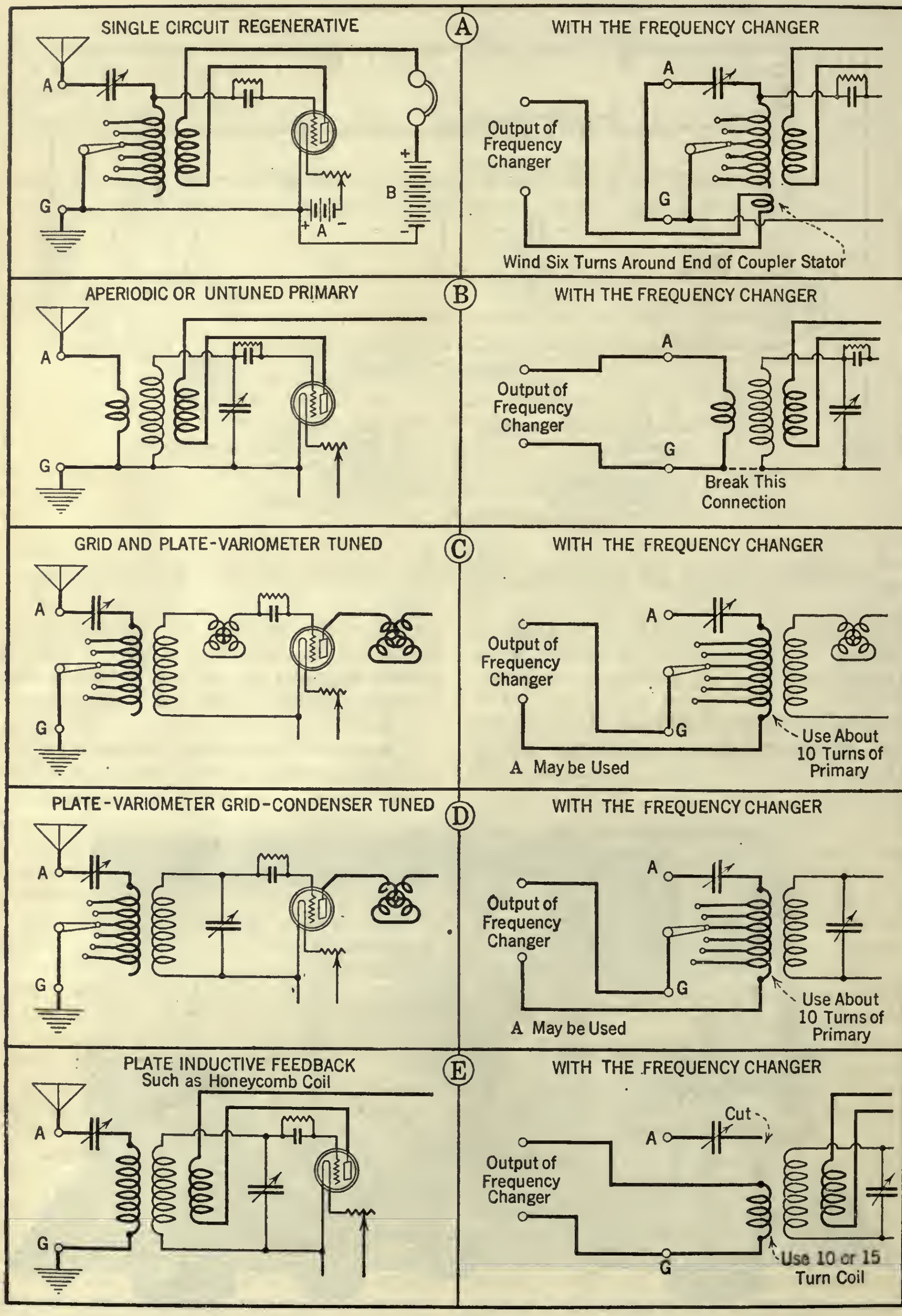


FIG. 3

Here is the whole family of single-circuit bloopers together with the methods of attaching the Frequency-Changer to them. In A and B are two methods of avoiding possible short-circuiting of the B battery

tubes will work properly. As a matter of fact, the 6-volt type is best, the 3-volt type second, and the $1\frac{1}{2}$-volt tubes a fair third. The operation of the Frequency-Changer and the receiver to which it is attached, is a simple matter. It is only necessary to tune the receiver to 600 meters or as near to it as possible, and crank up the regeneration to a point where considerable gain is evidenced, but not so far that oscillations actually take place. Once the tuning dial is set at 600 meters or near it, it will not be necessary to touch it again, since all tuning is done with the Frequency-Changer dials.

Both dials of the Frequency-Changer will tune nearly alike, and the tuning is sharp enough to demand a good vernier dial. Those on the Frequency-Changer illustrated in the photographs are Velvet Vernier dials made by the National Company, Inc. of Cambridge, Massachusetts.

WHY THE RECEIVER IS TUNED TO 600 METERS

THE object in using 600 meters is to place the intermediate-frequency amplifiers above the broadcasting wavelength bands to avoid interference. If the receiver will not tune high enough, a small fixed condenser, of, say .0001 mfd. capacity, may be placed across the tuning condenser, and the receiver tuned to some point well above the longest broadcasting wavelength. Many ocean vessels use the 600-meter band for ship to shore communication and one method of tuning the receiver to this wavelength is by listening for code signals. The exact wavelength is not important, as long as it is out of the broadcasting band.

In case no heterodyne action is noted, it may be necessary to reverse the connections to one of the two coils in the oscillator coupler, and for best operation it is well to try reversing the output connections from the Frequency-Changer.

The tickler of the pickle bottle coil will give regeneration which will be especially useful on distant stations, as well as sharpening up the tuning. If the coupling of the two oscillator coils is correct, the tickler of the pickle bottle coil will just cause oscillations when KSD or some other high wavelength station is tuned-in. With this setting, the tickler will not have to be adjusted more than three times when going down toward the lower wavelengths. Thus there are only two tuning controls.

In order to get maximum selectivity, a selector switch has been added which makes it possible to use three or six turns in the primary of the Frequency-Changer. The smaller number of turns may decrease signal strength somewhat but will enable the operator to cut his way through interfering stations with greater freedom.

One of the important points about this device when added to a single-circuit blooper is the fact that the blooper may oscillate without its radiation getting to the antenna. These oscillations are confined to the receiver itself, and do not pass through the Frequency-Changer to get out on the antenna. It is possible to tune-in stations by the usual "squeal" method, without annoying the neighbors—a most important point.

GUARDING AGAINST RADIATION

THE oscillator circuit itself does not radiate, and there is only one other adjustment that is liable to disturb the neighbors. If the tickler of the Frequency-Changer is turned until a click is heard in the phones, the Fre-

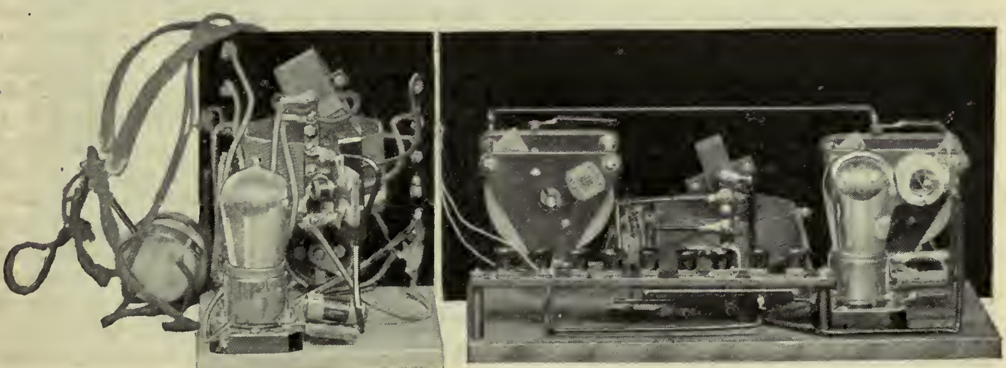


FIG. 4

Here is a two-tube super-heterodyne made by adding the Frequency-Changer to a single-circuit tickler feedback receiver. The addition of the Frequency-Changer improves the selectivity, adds distance, and eliminates all possibility of the receiver radiating into the ether

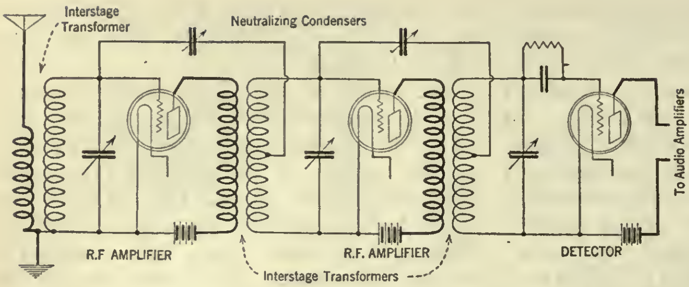


FIG. 5

This is the conventional neutrodyne diagram of connections. Without the neutralizing condensers it would represent the connections for the first three tubes of the usual five-tube tuned radio frequency receiver

quency-Changer is oscillating at the frequency of the incoming signals and will radiate at this frequency. But the minute this occurs, the whole system becomes inoperative, no signals get through to the loud speaker or head phones, and the operator naturally turns down the tickler. For this reason, the danger of parasitic oscillations going out into the ether is remote, and at any rate will only last a second or two.

When attached to a single-circuit receiver as shown in Fig. 4, the two tubes make phone reception from distant stations easily possible. With the addition of two amplifier tubes, loud speaker operation in Cleveland was possible from WHAS on 750 kilocycles (399.8 meters) and WGY on 790 kilocycles (379.5 meters) when WEAR or WTAM on 770 kilocycles, (389.4 meters) were operating, and without hearing the local stations at all. Equal selectivity was enjoyed in the Laboratory of Radio Broadcast although the "local" stations in this case were about 20 miles away. KSD, St. Louis, was heard in Garden City while New York stations were operating. This was an indication of the sensitivity of the receiver since KSD is rarely heard in the Laboratory under the best conditions.

THE FREQUENCY CHANGER APPLIED TO NEUTRODYNE

BY FAR the greatest application of the Frequency-Changer is in connection with the many neutrodyne receivers. There are possibly 400,000 of these receivers in the United States, and each of them is a potential superheterodyne with all of the advantages of this selective receiver, and without some of the disadvantages that both the neutrodyne and "superhet" possess. With the addition of the Frequency-Changer, the neutrodyne, whether it is good, bad, or indifferent, lifts its head and becomes a full fledged "super" with two stages of neutralized intermediate frequency amplification, and if the audio frequency transformers are good, and provided that the proper C batteries are used, the six tubes then in operation will provide a receiver that will be hard to beat.

In Cleveland the average neutrodyne will not tune sharp enough to approach within 50 meters of local stations without interference. Although other stations may be heard the local is heard also, and "we don't count them, if we hear the local." A Frequency-Changer added to a four-tube reflexed neutrodyne, such as the Fada four-tube, or the Ware, or others, and operating on a long antenna has so improved selectivity that WGY and WHAS (whose wavelength is 10 meters from locals) can be brought in without interference from WTAM or WEAR. Attaching the Frequency-Changer to a five-tube set enables the operator to use a loop, and under these conditions, stations in Philadelphia (whose wave is 5 meters wavelength away from locals) may be picked up without local disturbance. The reflexing feature seems to make no difference in the selectivity of the outfit, but the loss in volume is clearly noticeable.

Tuning is sharper when using a loop, although some volume is naturally lost. A five-tube neutrodyne with a Frequency-Changer at-

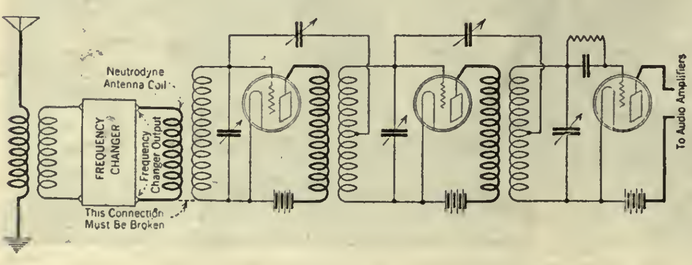


FIG. 6

The addition of the Frequency-Changer to a receiver like that of Fig. 5 is a simple matter as this diagram shows. It is important that the connection indicated be broken to avoid shorting the B battery

tached to a collapsible loop has picked up California from Cleveland during the month of February, although this is to be regarded as a stunt, and not regular performance. One thousand mile reception in favorable weather is the usual range of such a hook up.

Let us examine the neutrodyne circuits and apply the Frequency-Changer to them. Fig. 6 illustrates the essential connections of a five-tube neutrodyne set. Fig. 7 shows a tuned radio frequency set with a Frequency-Changer added to it. The output circuit of the Frequency-Changer is connected only to the aperiodic primary of the first neutroformer. In a neutrodyne set, the primary is usually connected to both negative A and ground, *and it is absolutely necessary to disconnect the negative A connection* as we did with the single-circuit set. This will eliminate all danger of short-circuiting the B battery which is connected through the output circuit of the Frequency-Changer.

VARIOUS TYPES OF NEUTRODYNES

SOME neutrodyne sets have but one winding in the first transformer, the antenna and ground being connected to taps on this winding as shown in Fig. 8. This method of getting coupling to the antenna cannot be used in connection with the Frequency-Changer due to the fact that the output of the unit carries 45 volts of B battery. A pair of phones and a small battery, such as a C battery, or a few volts of B battery are all that is necessary to ascertain whether such a coupling method is used or not. The phones, battery and antenna may be connected in series, and the remaining wire touched to the filament of the first tube, as shown in Fig. 9. If a click results, it is evident that the antenna binding post is connected to the first coil and naturally through the wiring back to the B battery.

An additional winding must be used in

FIG. 7
With the addition of the Frequency-Changer to any of the well-known neutrodynes, or the radio frequency receivers, the owner has an excellent six-tube superheterodyne that may be operated on a loop from medium distant stations. The receiver illustrated here is a well-known five-tube radio frequency set

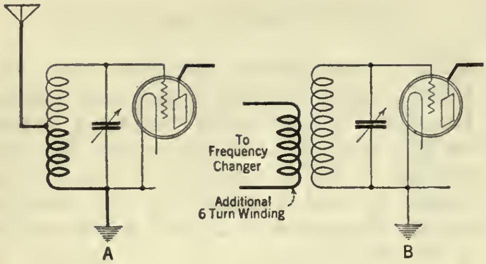


FIG. 8

It sometimes happens that the antenna is connected to the receiver as shown in A of this Figure and the method of adding the Frequency-Changer is illustrated in B, where a few turns of wire are wound around the grid coil of the first tube

such cases and the method of connecting it into the circuit is shown in Fig. 10 where an aperiodic winding of six turns of No. 20 d. s. c. wire are wound on the outside of the coil and separated from it by a thin layer of empire cloth.

HOW TO TUNE

A GREAT many neutrodyne sets are perfectly neutralized, and in this case the operation will be all that can be desired. The great majority, however, might be better neutralized and the sets oscillate when being tuned. If such a receiver oscillates at present (squeals when tuning), we would advise adding a 200-ohm potentiometer, as is illustrated in Fig. 10. When the arm on the potentiometer is rotated toward the negative A binding post, the set will operate as it did before the potentiometer was added, and will oscillate. By turning the arm away from negative A a very short distance, the oscillations will cease and perfect tone will result.

Tuning is done in exactly the same manner as with the single-circuit regenerative receivers. If it is known that your set will tune up to 600 meters, set all three dials at the point where 600-meter stations are tuned-in. The

FIG. 9

A pair of phones and a battery are all that are needed to determine whether the receiver is wired like that in Fig. 8. One of the wires going into the cabinet is connected to the antenna binding post and the other to the grid coil of the first radio-frequency amplifier tube. If there is a click it demonstrates that the antenna is directly connected to this first coil

three dials of a neutrodyne set run fairly close together and the change in wavelength per dial degree will enable the operator to determine just where to tune for 600 meters. For instance, let us suppose that two stations near the top of the condenser dial are 20 meters apart, representing a change of 4 degrees on the dial. Then each degree represents 5 meters change and it is a simple matter to calculate where 600 meters will be. Now pick up stations on the Frequency-Changer and check with the calibration chart in the next column. If stations are considerably below the reading on the chart, it will be necessary to tune your neutrodyne still higher. A strong oscillation point may be found at the upper

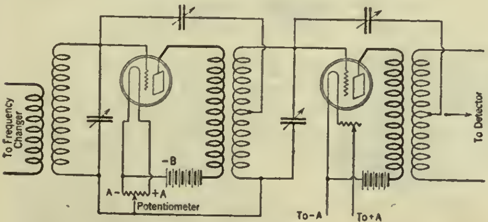


FIG. 10

If the neutrodyne or the tuned radio frequency set has a tendency to oscillate when in tune, the addition of a potentiometer will aid in controlling the amplifiers. The method of making this addition is illustrated in this Figure

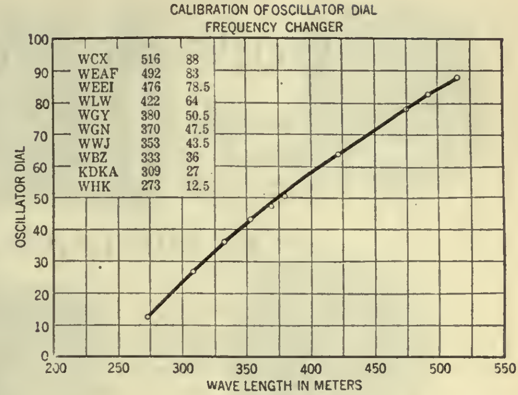


FIG. 11

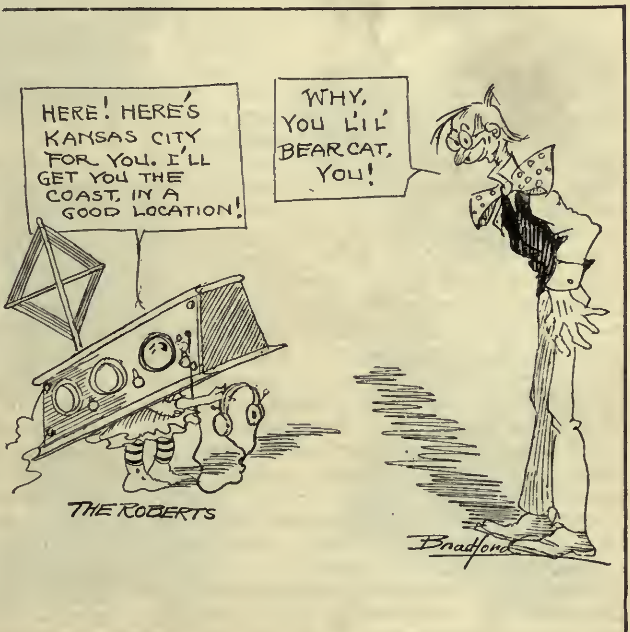
This chart shows the relation between the oscillator dial numbers and the wavelengths to be received. If the intermediate amplifiers are tuned to 600 meters, the tuner dial figures will be very near those shown on this chart

part of your oscillator dial. This means that the Frequency-Changer is interfering with the neutrodyne setting. By tuning the neutrodyne up to 600 meters this oscillation point will be eliminated. If the receiver will not tune to 600 meters, connect a .0001 mfd. fixed mica condenser across the three variable condensers, which will effectively increase the upper tuning range.

W. R. Bradford

READERS of RADIO BROADCAST read with much sympathetic interest and the tribute of an earned smile the article by W. R. Bradford. "Radio Heaven Via the Roberts Circuit," March, 1925. His cartoons we have used were popular too. The cartoon at the right was sent in to us just a short time ago by Mr. Bradford from his Philadelphia headquarters at the *North American*. Mr. Bradford was a great booster for the Roberts circuit with which he had great success.

After a short illness, Mr. Bradford died at his home in Philadelphia, on the 6th of June. He had been for a number of years, cartoonist on the *North American* and within the past eight months had been radio editor of the same paper. RADIO BROADCAST records the death of Mr. Bradford with the knowledge that newspaperdom has lost an able cartoonist and writer. Radio enthusiasts have lost from their ranks a genuine and earnest experimenter.



Coils and Condensers

A Discussion of Present Tendencies of Radio Design as Evidenced by Tuning Apparatus Produced by Well Known Radio Manufacturers—Two New Receivers

By THE LABORATORY STAFF

THE Radio Broadcast *Laboratory was founded for two reasons, to protect its advertising pages and to provide a fund of information upon which our readers might draw. The purchaser of radio equipment has little chance to find out what is wheat and what is chaff among the material that is for sale—that has become the task of the Laboratory. Whatever information it has, will be contained in these pages for the benefit of our readers.*

It is obviously impossible to test in the Laboratory, or to illustrate, or even to mention all radio equipment that appears for sale. Last year there were 400 manufacturers of condensers alone and to test all of their products would make it impossible for the Staff to know about anything else.

The apparatus illustrated or mentioned in these pages is neither all that is tested in the Laboratory nor what the Laboratory believes to be the best on the market—it is merely representative equipment. It is obvious that nothing in which the Laboratory does not believe will be described, nor will advertisements of poor apparatus coming from unreliable concerns be included in the magazine.—The Editor.

THE tuning elements—coils and condensers—are, perhaps, as important as any apparatus that goes into radio receivers. Upon them depends the strength of signals and the selectivity of the receiver. The quality of reception depends upon other apparatus.

Much effort has been spent in making good condensers, and it is probable that the ultimate has been reached in "low loss" condenser design. Several important trends are to be noted among condenser manufacturers. The first is the attempt to make condensers of "low loss," the second is the tendency toward "straight line" wavelength or frequency curves, and the third is the advent of condensers and dials which turn through 360 degrees instead of the orthodox 180 degree instruments.

Readers interested in the low loss business, will do well to read the results of work done by Sylvan Harris and published in the Proceedings of the Institute of Radio Engineers for February, 1925. An abstract with the available facts has been placed in a small booklet by the Rathbun Manufacturing Company which shows that practically all modern condensers are "low loss"; in other words, one is as good as another as regards electrical efficiency. The figures show that there is little, if any, difference between condensers with metal or composition end plates, although it may be significant that practically all of the manufacturers are using metal end plates —and that the General Radio Company, one of the oldest builders of quality radio equipment, uses composition plates.

The tendency toward condensers that distribute the broadcasting stations evenly over the entire dial is much to be desired.

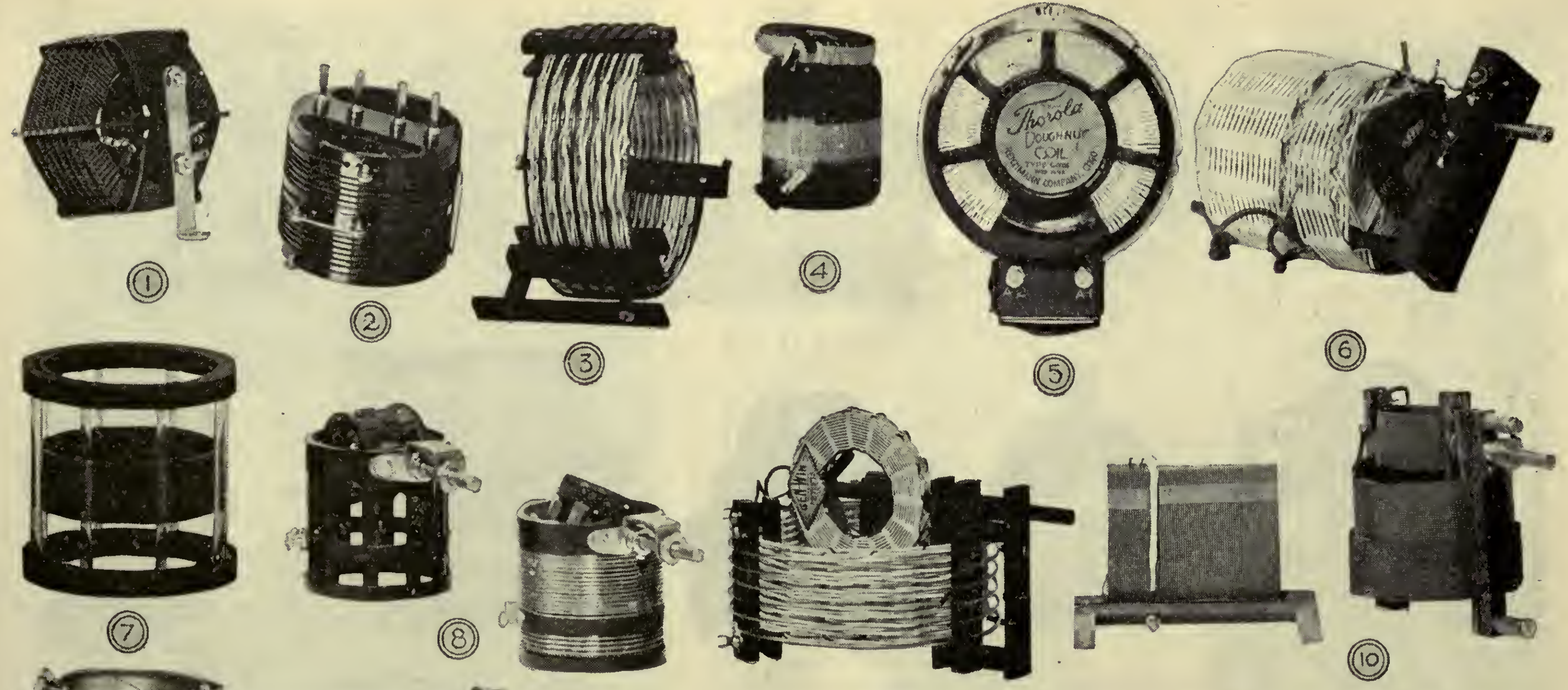
In the older condensers, the capacity varied directly as the angle through which the plates turned, so that the relation between the marks on the dial and the capacity of the instrument could be represented by a straight line. This condenser bunches the stations operating on high frequencies (low wavelengths) and spreads apart those on the lower frequencies, an obvious disadvantage, since there are more stations on the higher frequencies.

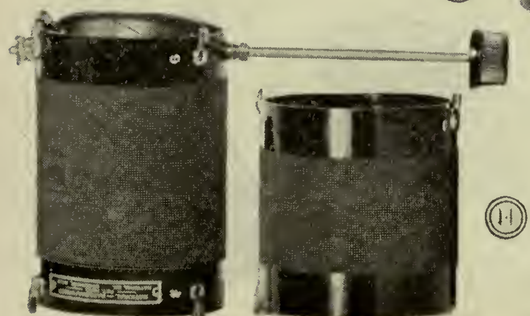
There are two methods of avoiding this difficulty. One is to make a condenser which will distribute all stations according to their wavelengths, and the other is to distribute them according to their frequencies. In other words if Class B stations are 10 kilocycles apart in frequency, they will be a certain number of condenser degrees apart whether they are at the high or low end of the frequency gamut.

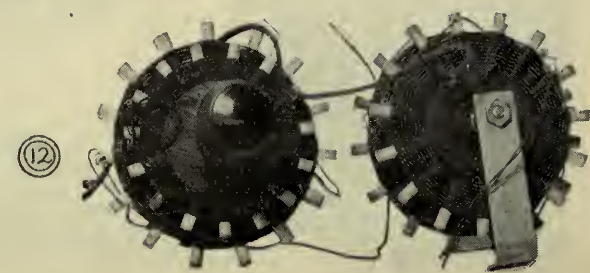
There is little difference between these two methods of attaining the same object, except that it is simpler to talk frequencies and more scientific—when we all get used to it.

The shape of the plates determines the capacity curve, and many and strange are the modern condenser plates. Some manufacturers make them strange to begin with, while others cut holes in an ordinary semi-circular plate. The cutting away of an orthodox plate is the usual method, and the Kellogg, the newer General Radio, or the Lacault condensers show this method. The business of carving something from the center of the plate is shown on our photograph by the New York Coil Co. The Rathbun condenser has part of the plate interior cut away, although the illustration does not show it.

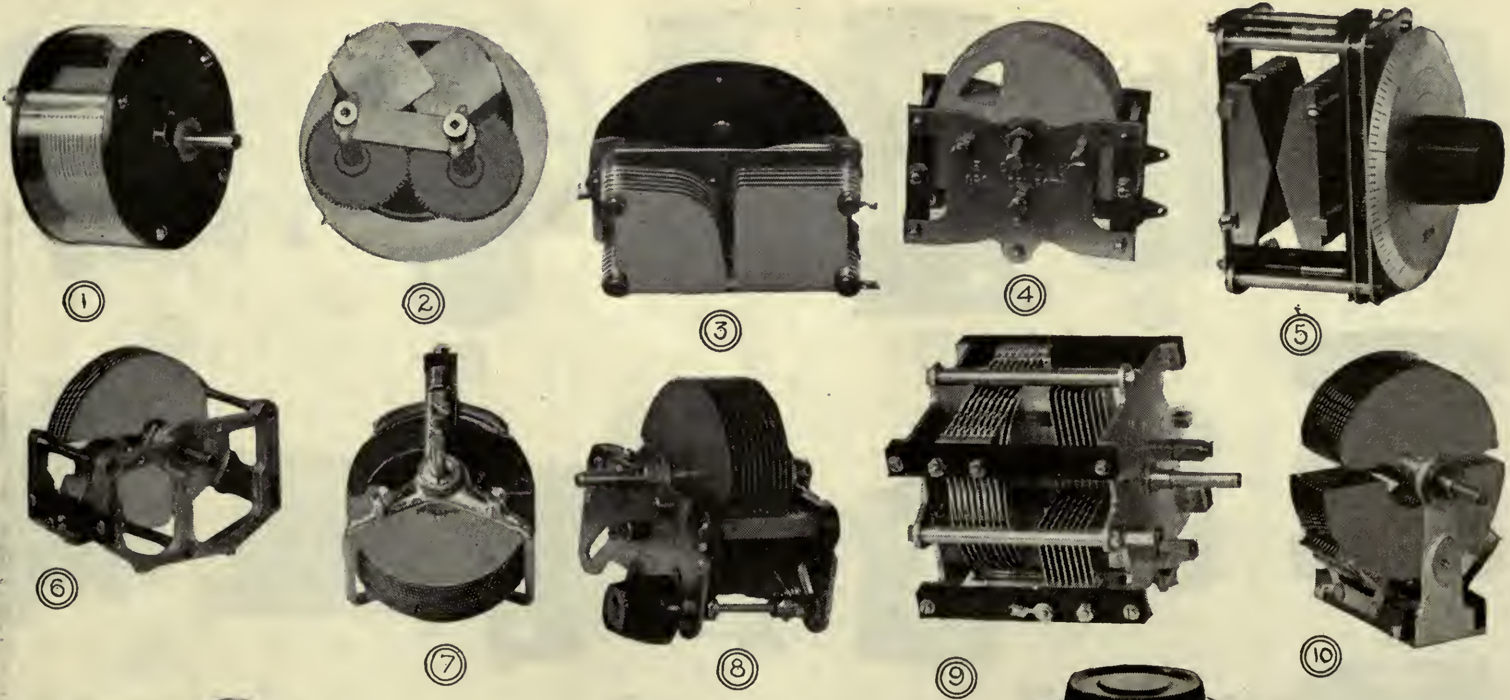
The third factor in modern condenser design, the 360-degree dials is important. Instead of grouping the eighty-odd Class B and innumerable Class A stations into half a dial, or 180 degrees, they are

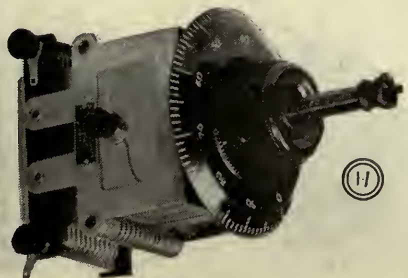




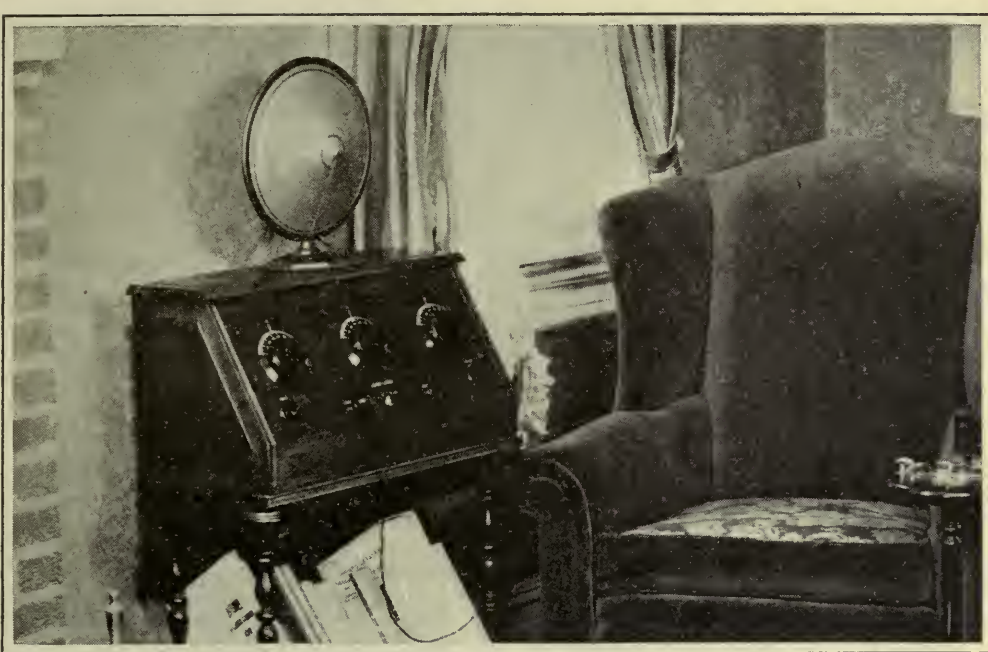


1. Radio Units, Inc., Maywood, Ill.
2. General Radio Co., Cambridge, Mass.
3. Globe Radio Equipment Co., New York City.
4. Radio Foundation, Inc., New York City.
5. Reichmann Company, Chicago, Ill.
6. Perfection Radio Mfg. Co., Philadelphia, Pa.
7. Bruno Radio Corporation, New York City.
8. Ambassador Sales Co., Inc., New York City.
9. General Radio Winding Co., New York City.
10. Eastern Coil Corporation, New York City.
11. National Co., Inc., Cambridge, Mass.
12. Victor Radio Co., Philadelphia, Pa.





1. Rathbun Mfg. Co., Jamestown, New York.
2. Remler Radio Mfg. Co., San Francisco, California.
3. Nelson Tool Co., Inc., New York City.
4. New York Coil Co., New York City.
5. Wade Mfg. Co., New York City.
6. Bremer-Tully Mfg. Co., Chicago, Ill.
7. Phenix Radio Corporation, New York City.
8. American Brand Corporation, Newark, N. J.
9. The Allen D. Cardwell Mfg. Corporation, Brooklyn, N. Y.
10. Kellogg Switchboard & Supply Co., Chicago, Ill.
11. Barrett & Paden, Chicago, Ill.
12. General Radio Company, Cambridge, Mass.



TWO NEW RECEIVERS

These receivers mark the entry of two well known manufacturers into the radio field. The lower photograph is that of the Stromberg Carlson Neutrodyne, a five-tube receiver that conforms to the best type of home decoration, and in the Laboratory proved itself to be an excellent receiver. The loud speaker is also from Stromberg Carlson. The upper receiver is made by Stewart Warner, manufacturers of a complete line of radio equipment, including tubes. This receiver is a five tube, tuned radio frequency amplifier set and is housed in a beautiful cabinet

distributed around the circumference of a complete circle with somewhat greater ease of tuning.

WHAT IS A GOOD COIL?

COILS have come in for their share of attention too, although it must be said that it is a much greater task to build an efficient coil than an equally efficient condenser.

A coil has but one purpose in a receiver, and that is to furnish inductance to the circuit. Unfortunately it also has resistance and capacity, neither of which is desirable.

A good coil then, has a maximum of inductance, a minimum of resistance and a minimum of capacity. The first two determine the selectivity of the receiver and the strength of signals. The capacity of the coil determines the highest frequency (lowest wavelength) that can be received with a given condenser.

All coils have a magnetic field surrounding them. This field is usually useful but does a lot of things it should not, and is difficult to measure. In general, the larger the field, the more space the coil requires, the greater will be the losses in the coil when in a receiver, and the greater will be the danger of unwanted coupling with other parts of the circuit.

When a coil comes to the Laboratory, the first thing that is done is to measure its inductance, then its resistance at various broadcasting frequencies is determined, and then its relative efficiency determined. Unfortunately, these measurements are not the same when the coil is actually in circuit, but are a good measure of how well it will work in a receiver. Never yet has a coil that was poor in Laboratory measurements proved to be excellent when in actual operation.

Coils of all types, solenoid, spiderweb, basket weave, what not have been tested. If they were wound with average sized wire, with a minimum of dielectric and without "stickem" to hold them together their losses were about equal. It is probable that the best type to-day is the old fashioned solenoid wound on "air", with the basket weave made with many pegs—so that it approaches a solenoid—a close second.

Spacing between turns is more important than most manufacturers realize, though the coils made by the National Company and wavemeter coils made by the General Radio Company, reduce losses made by this method. Elimination of dielectric is necessary for a coil to have very low losses. The use of large wire does not seem to reduce losses but it adds mechanical strength, an important point.

Skeleton forms made by the Ambassador Sales Co. Inc., and the Bruno Radio Corporation, are now available and if the wire wound on them is slightly spaced it is doubtful if better coils can be made by the home constructor.

TOROID COILS

WITHIN the last few months a new type of coil has appeared that offers much for radio. This is the "toroid" coil and is designed to have a small external magnetic field. This small field makes it possible to place the coil near metal plates without the usual increase of coil resistance. This means that a receiver may be made more compact.

Since the external field is small, signifying that little gets out of the coil, it follows that little will get into it from the outside through unwanted coupling. For this reason two coils may be placed close together without regard to the angle between them. Signals will not be impressed upon a part of a circuit except through the channel provided for it to follow.

At the same time it should be possible to build a coil that will not fall below the standards of a good solenoid—especially when placed in the circuit where it is to be used.

Unfortunately there are some disadvantages to the toroid coil, for they cannot be tapped, for this destroys the toroid effect. It is difficult to get energy into the coils, except through the use of external coupling coils which may introduce both resistance and capacity—both of which decrease the efficiency of the coil. Regeneration must be added to a circuit through capacity feedback instead of the customary tickler. There is nothing wrong with this system except that it is unusual and not so well understood by the average constructor.

The Laboratory believes that the toroid coil is an important development in the proper direction, and specimens made by the Pathé Phonograph and Radio Corporation, The Electrical Research Laboratories, and the Reichmann Company have been interesting and efficient inductances.

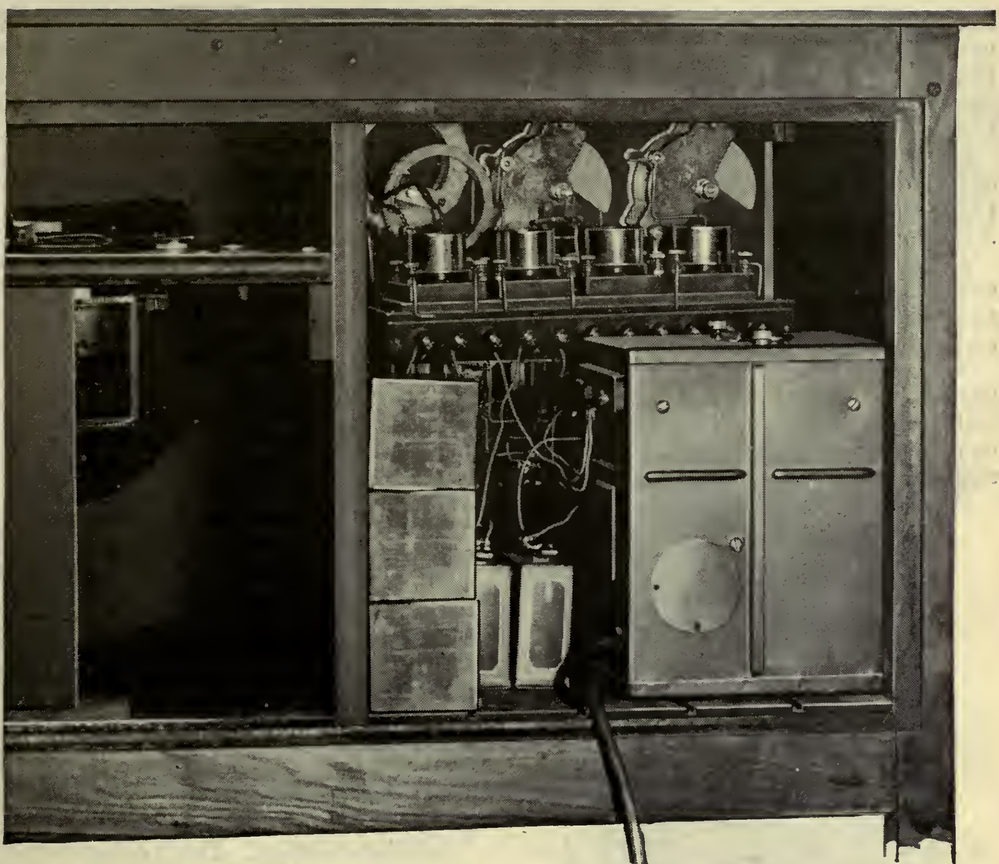
A useful dial recently added to the General Radio line and the American Brand worm geared condenser are devices that will make tuning a simpler problem.

THE COMBINATION OF COIL AND CONDENSER

THE combination of a coil and a condenser is the fundamental unit about which the entire receiver pivots, and a purchaser of such tuning elements should know that he is getting the best.

Condensers have been developed until there is little more to be expected in the way of eliminating losses. The "straight line" vogue is worth while. Condensers which have 360-degree tuning dials and which are illustrated in this article are made by Remler, Nelson Tool Co., Wade, and Barrett and Paden. The tandem condenser made by Cardwell and others is interesting in connection with increased simplicity of tuning, because two or more units can be operated on one shaft.

For some time it has been realized that coils could be improved, and the newer inductances wound with a minimum of dielectric, of fairly large wire, with space between turns, are steps in the right direction. Basket weave coils made by the Perfection Co., the General Winding Co., and the Globe Radio Equipment Co., have very low losses. The "baby" coil of the Ambassador Sales Co., is designed for the short waves and with a .0005 mfd. condenser, tunes from 50 to 150 meters. Basket weave coils, similar to those illustrated, but for the short waves are made by A. C. Lopez & Co., of New York City. The "Paddlewheel" coil made by Radio Units Inc., is a distinctly different type, and is effectively used in the Deresnadyne receiver.



RADIO BROADCAST Photograph

USING RADIO BROADCAST'S PHONOGRAPH RECEIVER ON A. C.

In tests made in RADIO BROADCAST's Laboratory it was found that the Balkite B could be used in connection with the Phonograph Receiver without causing any hum even though located in the same compartment as the receiver itself. The illustration shows the A, B, and C battery arrangement for use with dry battery tubes. Where standard tubes are employed it will be found that a small storage battery may be used in the same space without difficulty

More About Radio Broadcast's Phonograph Receiver

A Few Tips on Wiring, Circuit Juggling, and Operation Which Should Be Found Useful for Home and Portable Models

BY ARTHUR H. LYNCH

ALTHOUGH we have called our latest receiver by a name which would indicate at first thought a somewhat limited use, the applications to which it may be put are many and the manner in which it performs has already made it the most talked of receiver for home construction offered the radio public for many moons. We have not and do not expect to make any astounding claims for ease of assembly or performance. We do claim that RADIO BROADCAST's Phonograph Receiver is the most prac-

tical application of a circuit which in itself is unusually good and that the receiver is still further one of the most practical receivers for operation by the whole family which has ever been devised.

Some of the interesting points of excellence of this receiver which are of more interest to the family than to the enthusiastic circuit fan are:

Exceptional tone quality. Operating the receiver on either two or four tubes produces real music and speech which makes it easy to recognize the voice characteristics of the speaker.

Satisfactory volume. On two tubes, local stations may be received on the loud speaker with enough volume to fill the average living room, and distant stations may be heard in a similar fashion at night. On four tubes the volume may be made unusually great, and with a good loud speaker the music may easily be made loud enough to provide dance music for a large hall. One of the advantages of this receiver is that the loud music retains its tone because of the design of the tone amplifier circuit.

Radio Broadcast Photograph

A TYPICAL PHONOGRAPH

The panel used is somewhat larger than that required for an upright type Victrola. It will be observed that the layout of the equipment has not been changed in any way and that the assembly allows plenty of room for records. In a cabinet of this kind there is plenty of room for all of the batteries

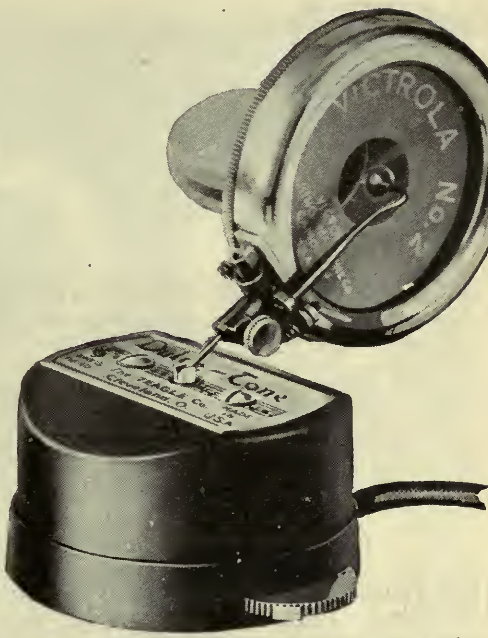
Ease of operation. When the plug is inserted in its receptacle, the current from the batteries is automatically turned on and only the actual number of tubes in use are lighted. When the plug is placed in the first receptacle, the receiver operates on two tubes; in the second receptacle, on four tubes. Whether two or four tubes are used, the finding of various stations and the control of their volume remains the same. Once the receiver has been set in operation and the preliminary adjustments made, it is but necessary to employ only two dials to choose the desired station and the dial settings usually coincide throughout most of the tuning range. Then, too, once a station has been logged it will be found again in the same place. The third, or volume control, need not be touched for ordinary operation but is put to work in building up the volume from distant stations when they would ordinarily be too weak. There is not a critical control in any one of the circuits, which means that the children may operate the receiver without any difficulty.

Selection of stations. This is one of the outstanding points of excellence in Radio Broadcast's Phonograph Receiver, which has been recognized by the home builders and other interested persons as soon as they have seen one of the receivers in operation. Where with many other receivers it is difficult or impossible to prevent entertainment from one station to be separated from another, the difficulty may usually be overcome when our new receiver is put to work. It will show up very well in direct competition with the best of the superheterodynes, which are recognized as the standard by which selectivity, or the ability to separate the desired stations, is judged.

The cost of the parts for this receiver is not too low to cause any one to doubt its practicability. On the other hand, it is not too high to cause alarm to any one who is the owner of a cabinet or console type phonograph. Using high grade parts, to be sure of the best performance, will bring the cost (exclusive of accessories) to about fifty dollars. In what other way would it be possible for you and your family to get as much real enjoyment for anything like that figure?

Your phonograph will do very well to house

this receiver, for it has been fitted into nearly every type of upright and console cabinet in our laboratory. In most of the phonographs we have used, there has been room for batteries of average size and since the receiver is economical in the drain on the batteries there is no reason for using batteries of more than average size. In fact, the drain is so small that the very small batteries, such as are used in portable receivers, may be employed with satisfaction. It is a simple matter to use the reproducing part of your phonograph with this receiver for a loud speaker and several combinations of this kind have been described in the two preceeding articles which appeared in Radio Broadcast for June, and July. As the accompanying illustrations will show, there is plenty of space, even in the upright type of phonograph for filing your records, even after the receiver and its accessories have been installed. For the small apartment, a better combination would be very hard to find.



Radio Broadcast Photograph

A PHONOGRAPH LOUD SPEAKER

By employing the Dulce-Tone made by the Teagle Company of Cleveland, Ohio in the manner indicated here, the tone chamber becomes the loud speaker horn and obviates the use of an outside speaker

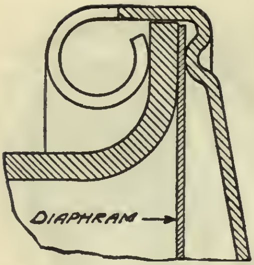
A FEW WORDS FOR THE CIRCUIT FAN

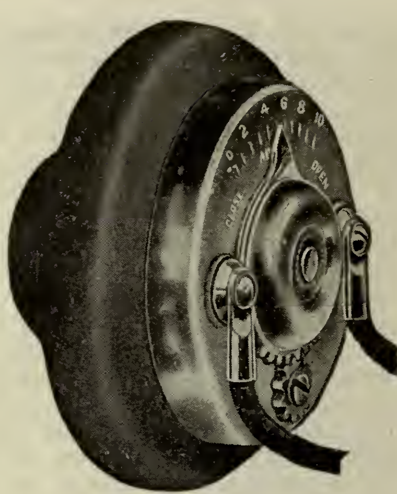
IN DESIGNING the receiver which has been described in the last three numbers of Radio Broadcast, we have attempted to keep in mind the needs of the class of folk who will derive most pleasure from the use of this receiver. It is not the last word in sensitive receivers, though it will out-distance any receiver we have seen with the sole exception of Radio Broadcast's Four-Tube Knockout Receiver and it compares very favorably with that. It is the kind of a receiver you can turn over to the family for their enjoyment, while you go ahead with your experimenting on another layout. Because of its compactness, some of the standard types of coils for use with the Roberts circuit can not be used and for your work on this circuit, if it is to be of an experimental nature, you may prefer the design described by John B. Brennan, our Technical Editor, in Radio Broadcast for September, 1924.

In connection with the phonograph receiver, as is also true of the Four-Tube Knockout, it is sometimes desirable to vary the plate voltage of the amplifying circuits, and we have found that it is possible to operate the reflex stage with but 45 volts on the plate circuit with some tubes, if the C voltage is reduced to 1.5 and the circuit is properly neutralized. It is rarely necessary to employ more than 22.5 volts on the detector plate, and we frequently use even less.

With some transformer combinations, we have found that an audio-frequency howl is set up when all four tubes are used and the juggling of the plate and bias voltages described above usually does away with that difficulty. If it persists, it may be overcome by connecting the cores of the push-pull transformers together by a short piece of wire. It is not necessary, as a rule, to ground these cores, but it is sometimes found of advantage. Another trick which seems to work well in eliminating any trouble which may arise in the amplifier is the switching of the two grid leads to the input transformer in the push-pull stage.

Some of the adaptations of radio devices which are now on the market to Radio Broadcast's Phonograph Receiver are shown in some of the accompanying illustrations. Others will suggest themselves to the experienced home constructor, and we would greatly appreciate having them brought to our attention. We are attempting, with this receiver design, to produce the most satisfactory results possible for the greatest number of radio listeners, with the least difficulty. Every unit which can be incorporated in this design will make our plan just so much more effective, because it will make it easier to procure the necessary parts.





A NEW PHONOGRAPH UNIT

A very interesting loud speaker unit employing the special design illustrated here has been made by the Radioceve Company. This unit can be had in various impedances in order to match the output impedances of the tubes used. In tests made in RADIO BROADCAST'S Laboratory it has been found very satisfactory

ADDITIONAL MODELS

THE two receivers, submitted to us by the Electrical Research Laboratories in Chicago, indicate very clearly how the devices made by that company, for other circuits, may be used in our receiver to good advantage. We recommend that receivers of this type be made with flexible wiring, however, and in our own work have found Acme Celatsite to work out very well. Number 18 bare, soft drawn copper wire does very well, when used with spaghetti.

The use of current tap devices, in the plate circuits has been tried and found very useful. Many of the tube type devices, such as the Mayolian, Mu-Rad, etc., have been used, but we have found that it is necessary to keep these devices some little distance from the receiver itself to prevent picking up the a. c. hum. Experiments with Balkite B show that it may be used right beside the receiver without causing any appreciable disturbance.

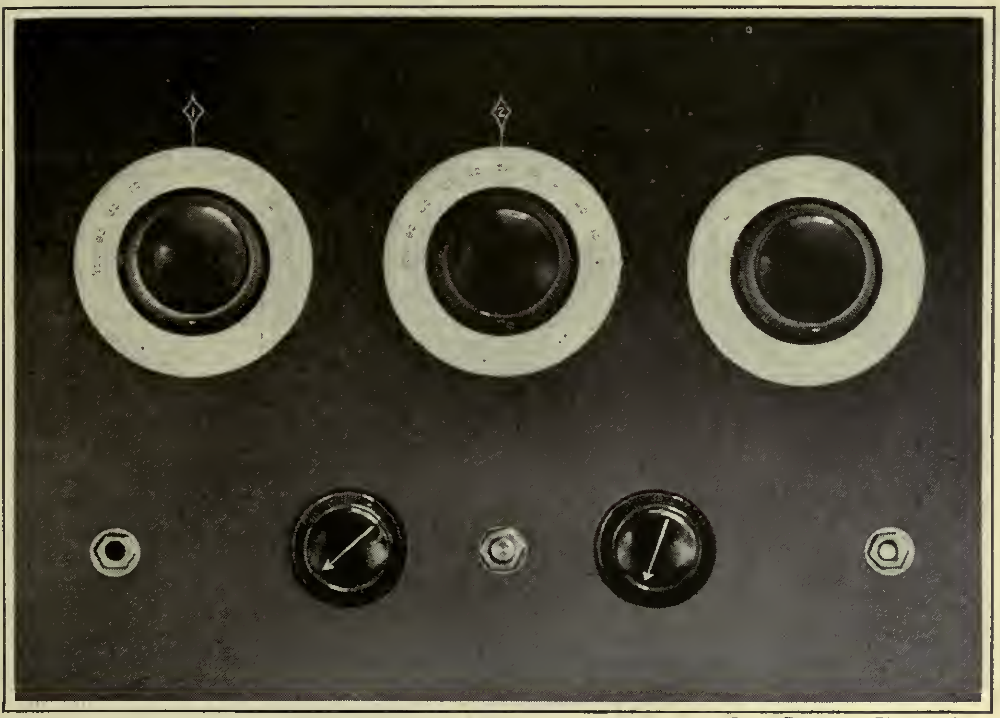
The new coils, which have been made by the F. W. Sickles Company for use in our phonograph receiver are shown on another page of this number, and we have found them to be very satisfactory. They may, of course, be used in any receiver, employing the now-famous Roberts circuit. Another new set of coils has been produced by the Victor Radio Company, and they have been found to be very satisfactory. Other manufacturers assure us, that they are going to put coils for our phonograph receiver on the market and the temporary shortage, which is now apparent, should soon be overcome.

If we have been successful in presenting a design which will satisfy the demands of the average listener, the average home constructor, we will feel greatly encouraged and believe that we are serving our readers in a satisfactory manner. We constantly strive to increase the number of people who derive satisfaction from the operation of their receivers.

Next month, if it is possible to carry out the plans we are working on, we will illustrate a new group of phonographs in which our receiver has been installed and will illustrate new devices now manufactured for use in connection with it.

Where the space occupied in your phonograph by our receiver will not permit the use of the regular storage battery equipment, it is possible to use dry-cell tubes and the very small type B batteries and flashlight batteries in the grid circuits for biassing.

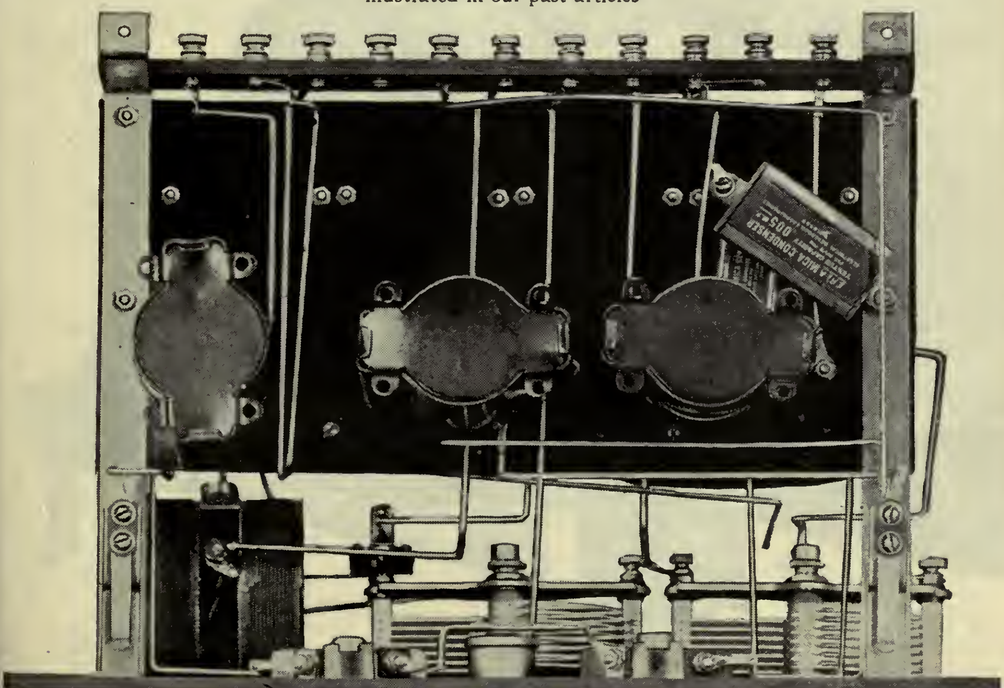
Additional photographs showing other applications of the Phonograph Receiver to various panels and equipment are found on the two following pages



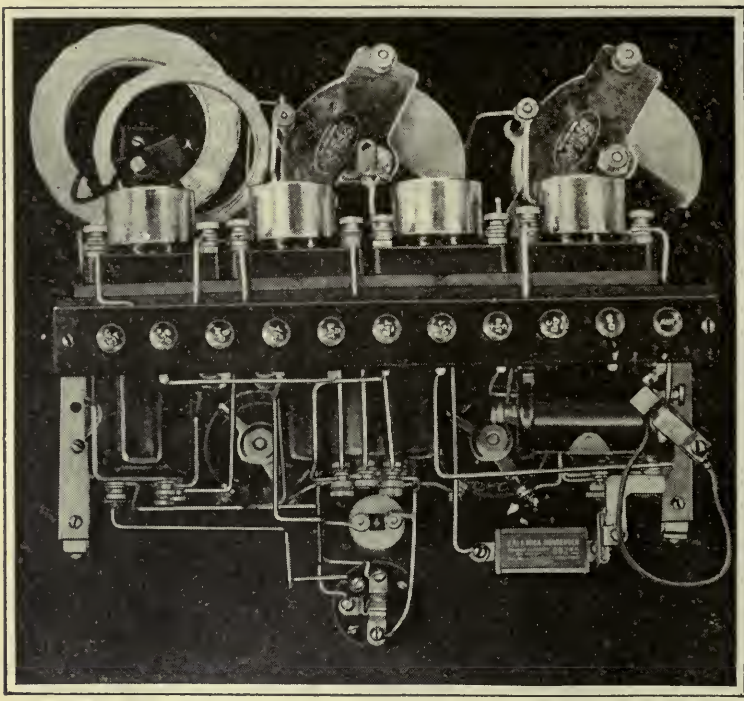
RADIO BROADCAST Photograph

RADIO BROADCAST'S PHONOGRAPH RECEIVER IS UNIVERSAL

This receiver composed entirely of parts made by the Electrical Research Laboratories in Chicago illustrates in a very comprehensive way the ease with which products of different design may be applied to our Phonograph Receiver. Some slight changes in wiring may be necessary and in this case the most significant one is the wiring of the transformers which is done above the sub-panel instead of below it after the manner illustrated in our past articles



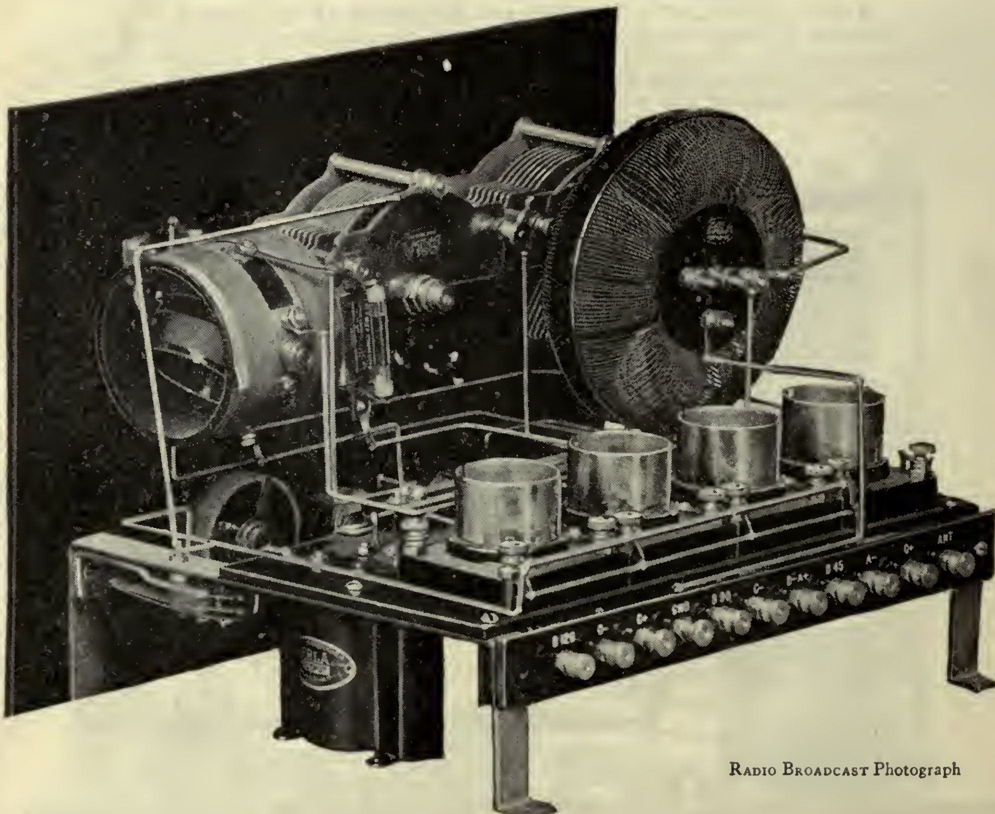
RADIO BROADCAST Photograph



THE ONLY DIFFERENCE

Between the two receivers illustrated here is found in the antenna circuit. In the upper receiver a Selectoformer has been used whereas in the lower receiver one of the Toroid coils made by the Electrical Research Laboratories in Chicago has been incorporated in the circuit. In building receivers of this kind it is much better for the home constructor to use flexible wiring instead of the bus bar illustrated here

RADIO BROADCAST Photograph



RADIO BROADCAST Photograph

"NOW, I HAVE FOUND . . . . ."

A Department Where Readers Can Exchange Ideas and Suggestions of Value to the Radio Constructor and Operator

NEUTRALIZING THE ROBERTS KNOCKOUT

PROBABLY the most satisfactory way to neutralize a tuned radio frequency amplifier is to use the method recommended by the neutrodyne manufacturers. This method may be applied to the Roberts with good results and eliminates the uncertainty of whether or not the amplifier is really neutralized or not.

A glance at the diagram, Fig. 1, shows that the Roberts consists of three circuits, tuned radio frequency, detector with regeneration, and the reflex circuit. It is because of the reflex circuit that ordinarily the regular method of neutralizing cannot be used, because in removing the first tube, the audio frequency circuit is broken.

However, if the reflex circuit is eliminated, we still have one stage of tuned radio frequency and detector with regeneration and can then proceed to neutralize in the regular manner, as in any other tuned radio frequency amplifier.

The procedure is as follows—remove the phones from their regular position in the plate circuit of the first tube in the circuit (X) and place them in the plate circuit of the detector tube (Y). We then have a set consisting of one stage of tuned radio frequency amplification, and a detector with regeneration.

In the two-tube set, when the experimenter removes the phones from X, it leaves the plate circuit of the first tube open. This may be remedied by short-circuiting a phone plug and inserting it in the jack or short circuiting the phone binding posts, as the case may be.

With the three-and four-tube sets this is not necessary as the jacks will take care of this.

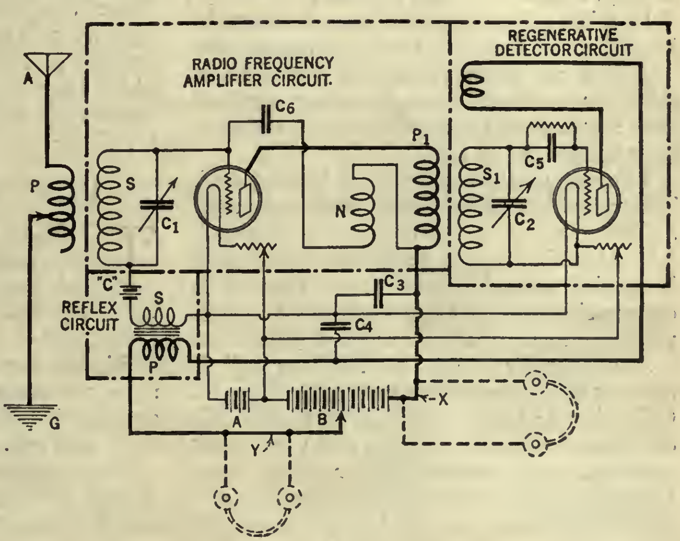


FIG. 1

Tune-in on a semi-distant station to maximum signal strength.

Then remove the first tube and insulate one of the filament prongs with a slip of paper or spaghetti and replace the tube in the socket. Retune to bring the signal to loudest point and then adjust the neutralizing condenser until the signal vanishes or reaches minimum strength. Remove the insulation from first tube, replace phones to their regular position, and as Roxy so ably puts it, "There you are."
—M. B. WHITNEY, Bethel, Vermont.

A SIMPLE AND EFFICIENT FORM FOR WINDING YOUR OWN COILS

IF YOU are interested in the Roberts Circuit here is an arrangement that will prove to be of a definite value to you in winding the necessary coils. A small block of hard wood (maple perhaps), is turned to a cylindrical form of $2\frac{1}{2}$ inches in diameter and $2\frac{1}{2}$ inches in length, as in Fig. 2. The circumference of this form is divided into thirteen equal parts. The easiest way to accomplish this is to lay out the circle on a sheet of paper, as in the diagram and make several trials at

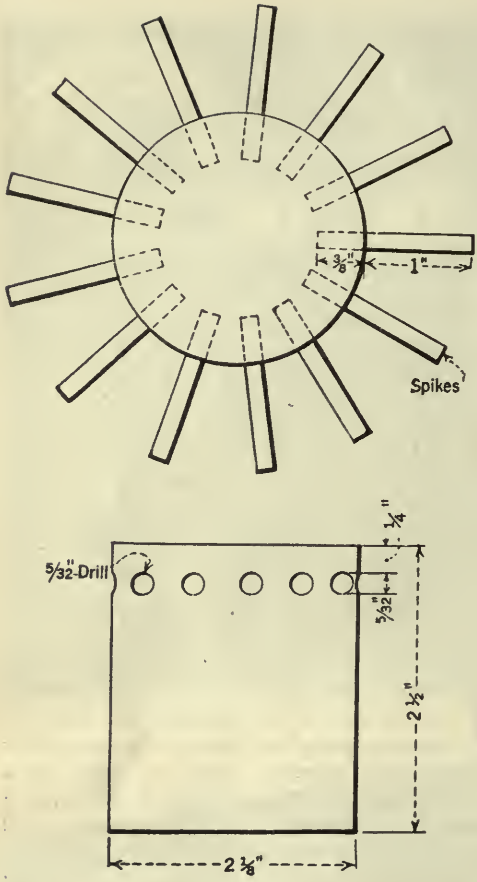


FIG. 2

division, and then when the result is satisfactory, transfer it to the cylinder.

In drilling the holes, care must be taken to keep them of the same depth on the centers. The pins are made from 4- or 5-inch nails. After the heads and points have been removed they should be cut approximately $2\frac{3}{4}$ inches in length, then cut in half.

Thirteen of these pins must be prepared. They should be rubbed with emery cloth until a fairly snug fit in the cylinder is produced. After the coil is wound, a small dab of collodion is applied to each intersection. The coil is quite easily removed by first twisting and then pulling out each pin with a pair of pliers.

And now for the coils. Antenna coil P consists of 40 turns with taps of 3-5-7-10-40. Coil S has 44 turns. All coils except the NP one are wound over two pins and then under two pins and so on with No. 22 d.c.c. wire. Coil NP consists of two wires of No. 26 d.c.c. wound together, over and under each pin twenty times. Try twisting these two wires together before winding. The tickler coil T consists of 18 turns of No. 22 d.c.c. wire.—Ralph Palmer, London, Ontario, Canada.

R. F. TRANSFORMERS AND HIGH PLATE VOLTAGE

IN WINDING radio-frequency transformers for an amplifier as described in the May Radio Broadcast it is common practice to place the "S" winding directly on top of the P and N windings. As the difference in d. c. potential between the "S" winding and either the P or N winding is generally in the order of 90 volts or more, the ordinary cotton covering of magnet wire is not to be depended upon. When this insulation between these windings breaks down, the result depends largely upon the condition of the B supply (mine is 140 volts of large size storage and the results were surprisingly complete). Just to play safe, in winding the coils put six or eight turns of heavy silk fishing line or other cord between the S winding and the P and N windings.

After having done this, the next and equally essential spot in which to place a safeguard is the neutralizing condenser circuit. I used the commercial type midget variables. These were none too well built and one of them shorted while being adjusted. Fortunately this short occurred on the proper side of the A battery and the tubes survived, but one of the r.f. transformers disappeared in a nice puff of green smoke. To avoid a recurrence of these pyrotechnics, I have put a .001 mfd. fixed mica condenser in series with the leads between the N coil and the variable neutralizing condensers These condensers are sufficiently large in capacity so as to have little effect upon the settings of the neutralizing condensers with which they are in series and the protection which they afford well justifies their cost.—M. K. T.

HELPS FOR CONSTRUCTORS

TO START a screw in an inaccessible place, rub some beeswax into the slot, push the point of the screw driver into the slot and place it where desired.

To recover a screw or other small part which has been dropped into an inaccessible place, put some beeswax on the end of a stick or suitably shaped tool, push it against the screw and remove it.

Never put a hot soldering iron into the can of acid soldering paste. It ruins the paste and the solder will not flow as easily or adhere as firmly as before. Even melting it down

from the sides of the can injures it. Acid soldering paste has no place in radio work anyway. Rosin core solder is just as easy to use if the surfaces are clean and the end of the solder is held against the metal in such a position that the melted rosin flows freely over the metal before the melted solder flows over it. Of course, the point of the iron must be clean and tinned to solder well with any kind of flux, and as the solder on the point becomes dirty from oxidation it should be wiped off. Solder will not adhere firmly unless the surface of the metal has been raised to a temperature high enough to melt the solder.—JOHN V. FREDERICK, Los Angeles, California.

WINDING COILS "ON AIR"

A GOOD form on which to wind the efficient "pickle bottle" coils, is made from a piece of bakelite tubing of the required diameter, which has a slot about $\frac{1}{8}$ inch wide cut through it lengthwise. The tube is then placed in a winding rig, the proper number of turns of wire put on and secured by narrow strips of gummed paper, or otherwise. After which the tube may be taken from the rig and the edges sprung together sufficiently to allow the coil of wire to drop off. The coil may then be further strengthened by putting narrow strips of gummed paper inside.

A SAFE HOMEMADE B SUBSTITUTE USING 110 VOLTS A.C.

THIS B battery substitute uses one toy transformer such as is sold for small electric trains, etc., and while it has been suggested before, this circuit was always considered unsafe, due to the fact that generally one leg of the alternating current line in household use is grounded. You can test this by putting a 110-volt light globe in a circuit in series with either of the 110-volt wires and a ground connection. If the globe lights up then that wire is not grounded, if it does not light, the wire touched is grounded.

In the case of the radio circuit the minus B is practically always grounded. In the case of this B substitute, we must have the same wire grounded, otherwise there will be a direct short and something will happen. Where the B transformer is set in a stationary place and permanently wired in to the 110-volt circuit the grounded side can be determined and the connections made accordingly. But where it is desired to merely screw a plug into any light socket for the B current the hook-up shown in Fig. 3 must be used. First a two-part screw plug should be used. Second a 110-volt light globe must be wired into the circuit as shown.

With the B substitute connected to the set and the ground (and it makes no difference whether the ground runs from the negative B on the set or from the B substitute unit,) screw the first half of the plug into the socket. Place the other half in place and if the bulb does not light the grounded wire is in circuit with the grounded negative B. This is O. K. However if it does light it indicates that the non-grounded side of the line is in circuit with the grounded negative B. This we do not want.

To correct matters, reverse the plug connection, by pulling it out and turning half around and insert. The bulb does not light in this position. The connections are now safe for operation of the radio set. This light globe also acts to prevent burning out of the tubes in case of a short circuit in the set.

The writer has used a B substitute on a three-tube set with 201A tubes and also on a 8-tube super-heterodyne using UV-199 tubes and has had excellent results.

A toy transformer of 75 watts capacity is used. For the choke a small bell-ringing transformer is used and two condensers of 3 mfd. each. An adjustable wire resistance controls the 201A tube used as a rectifier and I find it delivers ample current for the sets mentioned above.

The voltage delivered will range from 90 to 105. The proper voltage for the detector current can be obtained by inserting a resistance in the positive B line after taking off a tap for the amplifier voltage, which generally should be 90 volts. This B supply

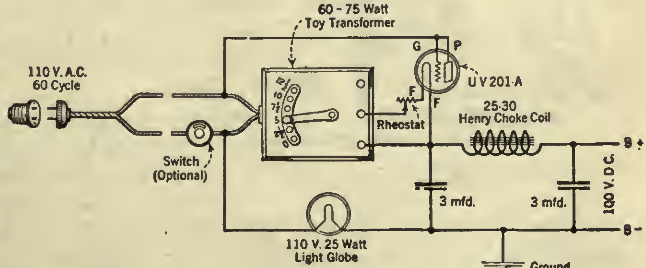


FIG. 3

substitute can be built for a cost not exceeding $12.50.

Alternating current hum will in no case be noticeable using the loud speaker. In the case of headphones, the a.c. hum is noticed when forcing the set on DX but not ordinarily. More condensers and chokes will eliminate the balance of the a.c. hum.—JAMES B. HAYS, Boise, Idaho.

RHEOSTATS AND VERNIERS CONTROLLED WITH HORIZONTAL DIALS

THE experimenter who wishes to incorporate a refinement and a novel mode of adjustment in his receiver may follow the suggestions in the drawings, Fig. 4.

The rheostat may be mounted under the socket in a horizontal position with the bracket, shelf, bushings and bolts. The dial used is cut from a piece of bakelite and the edge serrated with a file. It must be large enough to extend $\frac{1}{2}$ inch through the panel perforation.

The extra contacts of a vernier condenser, in which a low value (3 plate) unit is incor-

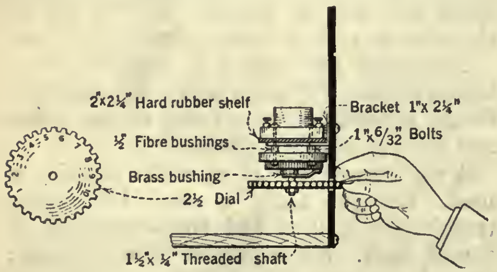


FIG. 4

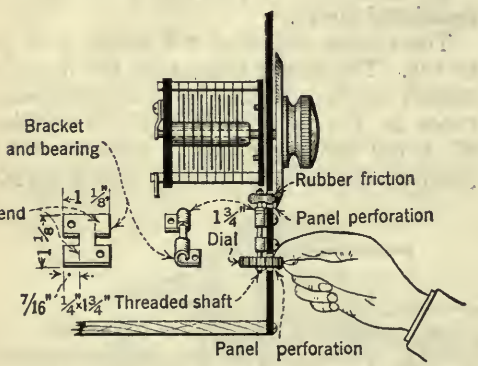


FIG. 5

porated, theoretically increase its internal resistance. Any condenser, variometer, or coupler dial may be fitted with a friction vernier as shown in Fig. 5.

The panel is perforated below and behind the dial and the vertical shaft is held in position by the bracket bearing which is cut and bent from heavy brass or copper. The shaft is fitted with a rubber knob at the top (the rubber may be part of an old shoe heel) which working through the apperture comes into frictional contact with the back of the dial. The dial at the other end of the shaft extends through the panel.

These dials may be turned with a sidewise rubbing movement which will give true micrometer adjustment.—J. T. GARVES, Huntington, Tennessee.

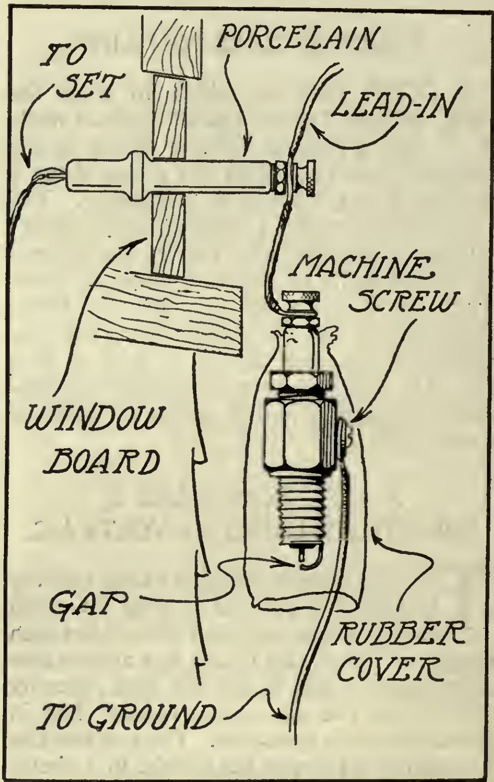


FIG. 6

RADIO LIGHTNING ARRESTER MADE FROM SPARK PLUG

A GOOD, serviceable lightning arrester that will give ample protection from lightning surges to the set can be made by any radio fan from old spark-plugs. All that is necessary to insure safety, is to see that the porcelain and shell are in good shape so that there are no leakages of antenna current to affect the reception qualities of the receiver.

The illustration, Fig. 6 shows the method of installation and is explained as follows.

Drill and tap a small hole in the shell as shown, and thread in a short machine screw with washer. Lead the antenna down to the terminal of a spark-plug porcelain thrust through a window board. The lead to the set can be soldered to the contact wire in the other end of the porcelain as indicated. That takes care of the connection of antenna to set and insures good insulation from the house.

Now hang the spark-plug previously mentioned from the binding post of the above mentioned porcelain by a short piece of wire. Then connect the ground wire to the shell by the machine screw and the arrester is complete. By tying a short length of old inner tube around the plug, rain will be prevented from short-circuiting the gap between the points of the plug. It is this gap that allows a surge of electricity from the antenna to pass down into the ground wire rather than allow it to pass through the set. It is the same idea as employed in many forms of commercial arresters and will do the work as well and at less expense. A separate ground wire will be necessary from the set to the ground connection.—L. B. Robbins, Harwich, Massachusetts.

MAKING HARD RUBBER SPIDERWEBS FOR THE ROBERTS SET

WITH the aid of the pattern published, in Radio Broadcast for January, 1925, cut a template from cardboard. Cut five 5 inch squares from $\frac{1}{16}$ inch hard rubber. Drill each square at its center to pass a $\frac{6}{32}$ machine screw, and snip the corners off so as to approximate a circle.

Make a jig from two pieces of hard wood about 10″ x 3″ x $\frac{3}{4}$″. The construction is shown in the sketch. Clamp the two pieces together, and drill three No. 28 holes, one $2\frac{5}{8}$ inches from the top, the second $3\frac{1}{2}$ inches below that, and the third an inch from the bottom. Remove the pieces from the vise and clamp them together with $\frac{6}{32}$ machine screws 3 inches long. Place the cardboard template underneath the head of the top screw; mark and cut the slot and top as shown.

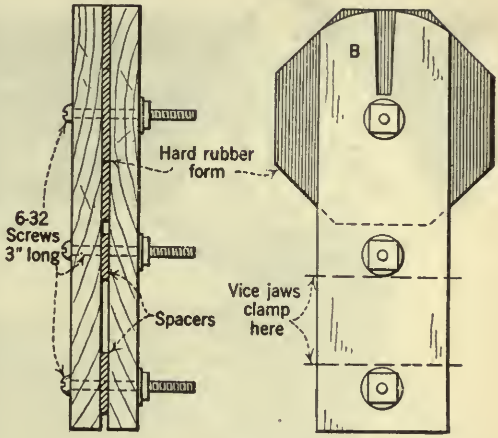


FIG. 7

Using the cardboard template, scratch the outline on the first rough form and clamp it between the two halves of the jig. Spacers are used to keep the halves of the jig parallel. Clamp the jig in a vise; line up the scratches of one slot and apply a clamp at B to keep the form from turning. Make two cuts with a hack saw. Knock off the waste material with a hammer and screw-driver. If the cut is stopped short of the bottom, the piece will break off above the danger point. Use a file to finish the slot and round the top. Loosen the clamp, turn the form to the next set of scratches, tighten the clamp, saw, chip, file, and continue the exercise until the form is finished. The jig and form is shown in Fig. 7.

If this first form is satisfactory, use it as a template to scratch another, as the cardboard form is probably *hors de combat* by this time. Then clamp the remaining four in the jig, the marked form being nearest you; and, if you keep everything lined up, you will have a good set of forms in short order.—Wayland S. Bailey, Cambridge, Mass.

THE "Now I Have Found . . ." department in this magazine is planned to furnish an outlet for the many excellent ideas dealing with various features of radio construction and operation which reach our office. If you have an idea about a valuable and useful new circuit, some new device or a construction or operating suggestion, we should like to have it. We do not want simple or obvious suggestions, and material to be acceptable for this department must offer something of definite value to the constructor; mere novelty is not desired. Payment from two to ten dollars will be made for every idea accepted. Manuscript should not be longer than 300 words and typewritten. An award of twenty-five dollars will be paid for the best article published in every three-month's period. Address your manuscript to this department, Radio Broadcast, Garden City, New York.

See the Announcement on Page 548

QUERIES ANSWERED

I WISH YOU WOULD RE-DESCRIBE THE WINDING OF THE COILS USED IN THE ROBERTS RECEIVER.
H. S.—Minneapolis, Minnesota.

HOW DO YOU APPLY THE ROBERTS NEUTRALIZATION TO THE NEUTRODYNE CIRCUIT?
B. O.—Coffeyville, Kansas.

SHOULD A RHEOSTAT BE PLACED IN THE POSITIVE OR NEGATIVE SIDE OF THE FILAMENT SUPPLY?
A. F.—Baltimore, Maryland.

WHAT PRECAUTION DO YOU ADVISE IN CHARGING B BATTERIES FROM 110-VOLT A. C. LINES?
H. W.—New York City.

WHY, IN THE HANSCOM "SUPER", DOES THE RECEIVER NOT OSCILLATE ON THE LOWER WAVES?
C. J. B.—Dover, Delaware.

WILL YOU PUBLISH A CIRCUIT OF AN EFFICIENT TRANSMITTER-RECEIVER?
J. A. H.—Augusta, Maine.

WILL YOU OUTLINE A SYSTEM FOR A COMMON AND STANDARD PRACTISE OF CONNECTING TOGETHER A AND B BATTERIES?
H. E.—Lincoln, Nebraska.

I WANT TO LEARN THE CODE. CAN YOU TELL ME A SATISFACTORY METHOD?
G. J.—Boston, Massachusetts.

HOW TO MAKE THE ORIGINAL ROBERTS COILS

MOST of the recent descriptions of receivers employing the Roberts system of neutralization have referred to the coil units as designed by Mr. W. Van B. Roberts and described by him in the April, 1924, RADIO BROADCAST.

Slight modifications were made in the design as described in the May, 1924, magazine which are now standard.

To make these coils, the constructor must have five spiderweb forms $2\frac{1}{8}$ inches inside diameter with

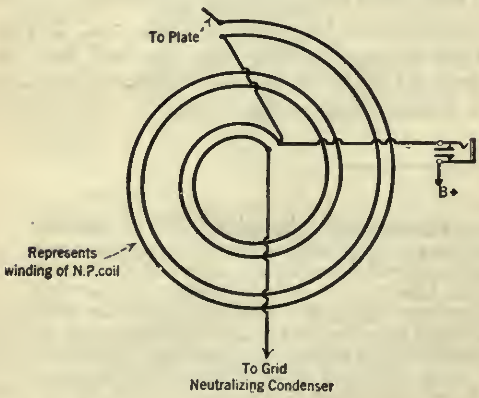


FIG. 1

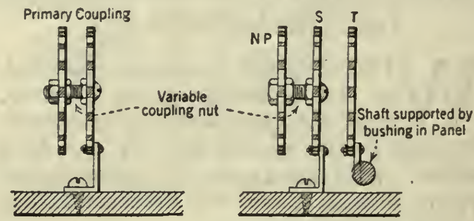


FIG. 2

spokes $1\frac{7}{16}$ inches long, $\frac{9}{16}$ inches wide at the top and $\frac{5}{16}$ inches wide at the inside diameter.

The antenna coil is wound with forty turns of No. 22 d. c. c. wire and tapped at the 1-2-5-10-20-30 and 40th turns. The secondaries are wound each having forty-four turns of the same wire. The tickler is wound with twenty turns. The N-P coil consists of a pair of No. 26 d. c. c. wires wound together for twenty turns. In these coils, the beginning of one and the end of the other are connected together and from this point a lead is brought to the top blade of the double circuit jack in the receiver.

The remaining leads of this coil connect, one to the plate and the other to the grid neutralizing condenser. See Fig. 1. The antenna, secondary, and tickler coils are wound over two and under two spokes. The N-P coil is wound under one and over one spoke of the coil form.

A mounting scheme is suggested in Fig. 2.

You may escape the collection ~ but not the need of OZARKA SERVICE

THE satisfaction you receive from your radio depends not on what it does once in a while—but night after night and month after month. Whether you grin or cuss depends on the service behind your radio.

Ozarka radio instruments are *only* sold by trained factory representatives, men who not only specialize in radio but sell and service Ozarkas only. 3,100 of these men, trained directly under Ozarka engineers constitute a service force, unequalled elsewhere in radio today.

When you buy a radio you'll compare appearance, tone, volume and selectivity by having various instruments set up in your own home but—that isn't enough—compare the service behind each one.

Any Ozarka factory representative will set up an Ozarka in your home—he will not even operate it himself, but will depend for his sale on what you yourself do. If you, by your own operating, do not bring in the distance, the volume and tone, you expect a radio to give, then you do not buy the Ozarka. If you do buy it, you can rest assured, no matter what happens, a competent service man is at your call at all times. No Ozarka representative can sell Ozarka Instruments without giving Ozarka service. You are entitled to such service—demand it!

That is why our book, "Ozarka Instruments No. 200," describing all models of Ozarka should be of particular interest to you. This book and the name of the Ozarka representative near you, will be sent immediately at your request. Please give name of your county.

We Have Openings for More Ozarka Factory Representatives

OZARKA Incorporated, is now entering its 4th year. From a beginning with one engineer, one stenographer, one salesman—our present president, the Ozarka organization has grown to over 3100 people. There must be some good reason for this growth.

Ozarka instruments have made good—they have more than met competition. Ozarka representatives have made good not only because Ozarka instruments were right, but because they have been willing to learn what Ozarka engineers were willing and capable to teach them—Ozarka unusual salesmanship and Ozarka service.

Radio offers a wonderful opportunity to men who are willing to start at the bottom and build. You need not know salemanship, but will you learn what we will gladly teach you? You may not know radio, but we can and will teach you if you will do your part. With such knowledge and willingness to work, it doesn't seem possible that you cannot make good. Sign the coupon below, don't fail to give the name of your county. Better still write a letter, tell us about yourself and attach coupon. If interested in our salesman's plan ask for "Ozarka Plan No. 100."

OZARKA INCORPORATED

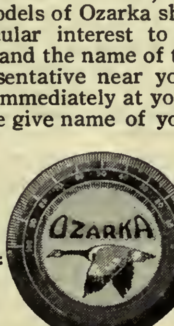
119 Austin and La Salle Streets
Chicago, Illinois

Gentlemen: Without obligation send book "Ozarka Instruments No. 200" and name of Ozarka representative.

Name..........

Address .... City ....

County.......... State..........



YOU'LL KNOW THE MAN BY THIS BUTTON!

119 Austin and La Salle Streets
Chicago, Illinois

Gentlemen: I am greatly interested in the FREE BOOK "The Ozarka Plan" whereby I can sell your radio Instruments.

Name..........

Address .... City ....

County.......... State ....

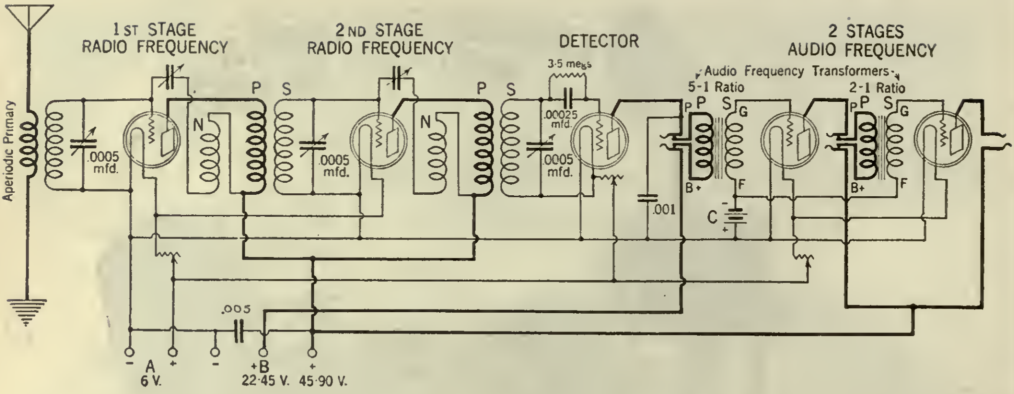


FIG. 3

AN R. F. CIRCUIT EMPLOYING ROBERTS NEUTRALIZATION

FOR a two-stage radio-frequency amplifier, with detector and two stages of audio-frequency amplification, the circuit in Fig. 3 is recommended.

The Roberts system of neutralization is employed and is recommended over the other forms of neutralization. In others, the maximum voltage gain is not realized, because the primaries of the usual couplers are wound with only six to ten turns of wire. In the Roberts system, more gain is obtained by the use of primaries of 20 turns. These primaries are double wound and connected as shown in the circuit diagram. No regeneration is employed but will increase the efficiency of the receiver when included.

It may also be found that two stages of straight audio frequency amplification will distort the signals received on account of not being able to handle the detector output properly. When this is the experience, push-pull or resistance-coupled amplification will usually prove satisfactory.

RHEOSTAT LOCATION

THE placement of a rheostat in either the negative or positive side of the vacuum tube filament supply opens up a question which is subject to much discussion. It is our purpose here simply to make some observations which may aid the experimenter in his constructional work.

In a detector circuit it is desirable to have the return side of the secondary coil connect to the positive filament lead so that a positive voltage be applied to the grid of the tube. This is quite necessary for rectification purposes.

Now in an amplifier circuit, it is desired to have the return side of the secondary of the audio transformer connect to the negative side of the filament lead so that the amplifying action will take place, figuratively speaking, on the straight portion on the vacuum tube characteristic curve.

By placing a rheostat in the negative line, a varying negative potential of from 0 to 6 volts may be obtained, providing the return side of the audio transformer secondary connects to a point on the rheostat winding. The value of this negative potential will depend upon the location of this connection on the rheostat winding.

Naturally if a C battery is used there is no need for obtaining a negative grid bias in this manner.

It is debatable whether or not any difference in operation can be noticed when comparisons are made with the rheostat first in one side and then in the other side of the filament leads where the return is made direct to the negative filament socket terminal.

In the December, 1924, Grid on page 304, Fig. 1, is shown the use of a C battery and potentiometer to give a smoothly varying value of negative grid volts. Of course such a circuit is practical for test and research purposes but not for ordinary continuous use. The shunting of a 400 ohm potentiometer across a 4½-volt C battery would discharge the battery at the rate of .011 amperes until it was completely run down.

HOW TO CHARGE B BATTERIES FROM A. C.

THE charging of storage B batteries presents a problem to the individual, especially where the house current is alternating.

Several months ago explicit instructions with diagrams were contained in the Grid showing the charging of B batteries from various d.c. line supplies.

This discussion will take up the charging of B batteries from a. c.

Usually, in a radio installation, about 96 to 124 volts of B battery are used. Now ordinary alternating current lines fluctuate in the voltage supply varying approximately from 106 to 115 volts for a 110 volt line. Generally the drop occurs at night when the lines are heavily loaded for illumination purposes.

Therefore, to be on the safe side it is well never to try to charge more than 96 volts (2 units of 24 volts in series) at a time. Because if the line voltage drops below that of the batteries they will discharge back into the line. Of course several banks of 96 volts each may be connected in parallel but the load on the line will be greater.

The charging device may be any one of several types such as the chemical rectifier, vibrating magnetic rectifier or tungar tube rectifier.

In the first named, the drop through the charger is about 30 volts so some means for stepping up the voltage must be employed. Transformers are on the market which will accomplish this.

The rate of charge depends upon the resistance of the circuit and voltage of the supply. The battery resistance is negligible so therefore some external resistance must be employed.

Vibrating rectifiers depend upon mechanically perfect construction and adjustment for satisfactory operation and will not be discussed here.

In the tungar rectifier, the tungar tube by an electronic rectifying action produces the desired effects. As there is a voltage drop through this tube the same means for stepping up the voltage as used for the chemical rectifier must be employed.

For circuit diagrams relative to the various points brought out herein the reader is referred to pages 230 to 236 of the July, 1924, RADIO BROADCAST.

WHY THE HANSCOM "SUPER" WON'T OSCILLATE ON LOW WAVES

IN THE usual radio circuits, experimenters have noted that on tuning to the lower broadcast waves, the tendency of the receiver to go into oscillation increases conversely with reduction in wavelength. In the Hanscom super-heterodyne, just the opposite phenomena has been experienced.

Mr. Hanscom explains as follows:—

> In regard to the tendency to oscillate on the higher waves, this is really a tuned plate effect of the first tube, the resonant point in the plate circuit being governed by the inductance of the Duratran transformer. We think that some of this difficulty may be due to long leads to the neutralizing condenser as it is customary for the set to oscillate at about 400 meters with the Chelten condenser set at zero. In general, the more turns on the loop the earlier the set will oscillate. In order to prove the case we suggest disconnecting the lead from the Duratran to the Chelton condenser after tuning in a low wavelength station, and it will be found that the signal strength materially increases. Unfortunately there is no small condenser on the market with a sufficiently low minimum capacity although we have had good success with a condenser employing three regular size plates which were cut away so that the rotor and stator plates were a considerable distance apart at zero setting.

The foregoing is an explanation of the broadness of loop tuning because the loop tuning becomes sharper as the oscillating point of the first tube is approached.

A TRANSMITTER-RECEIVER CIRCUIT

HEREWITH is described a transmitter-receiver circuit which of late has been in demand, especially by our English readers. The description of this apparatus originally appeared in the May 1923 RADIO BROADCAST.

The circuit comprises the usual one-tube arrangement with the exception that by means of a special keying system it also acts as a transmitter. It is especially desirable as a portable affair. Its only drawback lies in the maintenance of a fixed transmitting adjustment and at the same time allowing of tuning for receiving. Ordinarily transmission occurs at only one of two or possibly three prearranged wavelengths. The tuning and adjustment to resonance at these wavelengths is reasonably sharp so that to maintain two-way communication it would be necessary to shift wavelength adjustments, supposing that the two stations were not working on the same wavelength. As an example, if one station (A) works on 150 meters and the other (B) on 180 meters then A after concluding his transmission must shift his dials so as to listen in on

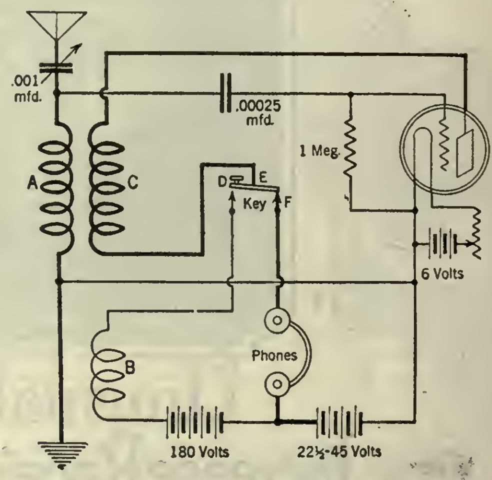


FIG. 4

180 meters (B's wave). Of course, this is not a serious disadvantage, but unless there is means for accurately retuning the set for transmission every time communication is maintained it makes it

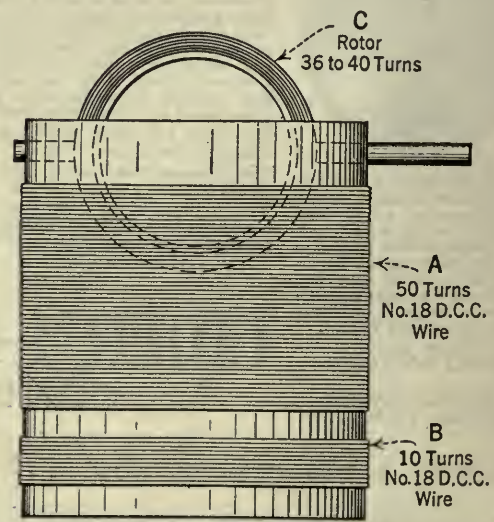


FIG. 5

PREFERRED

It is no accident that more Eveready Radio Batteries are purchased by the radio public than any other radio batteries.

Such complete and voluntary endorsement can lead to but one conclusion—for best reception and longest life, Eveready Radio Batteries lead the field.

You can prove this for yourself by hooking Eveready Radio Batteries to your set. You will find that they deliver a steady, vigorous stream of power that lasts longer. It is Eveready economy that has created such an overwhelming preference for Evereadys. There is an Eveready dealer nearby.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, Inc.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

EVEREADY
Radio Batteries
-they last longer

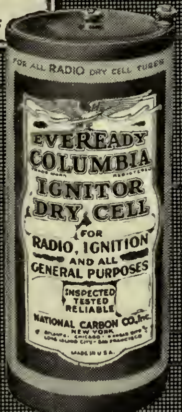
★

EVEREADY HOUR EVERY TUESDAY AT 8 P. M.
Eastern Standard Time

For real radio enjoyment, tune in the "Eveready Group." Broadcast through

WEAF	New York
WJAR	Providence
WEEI	Boston
WFI	Philadelphia
WGR	Buffalo
WCAE	Pittsburgh
WEAR	Cleveland
WSAI	Cincinnati
WWJ	Detroit
WCCO	Minneapolis / St. Paul
WOC	Davenport

Eveready Columbia Ignitor "A" Battery The proven dry cell for all radio dry cell tubes 1½ volts



No. 772
45-volt
Large
Vertical
Price
$3.75

No. 767
45-volt
Large
Horizontal
Price
$3.75
With
variable
taps

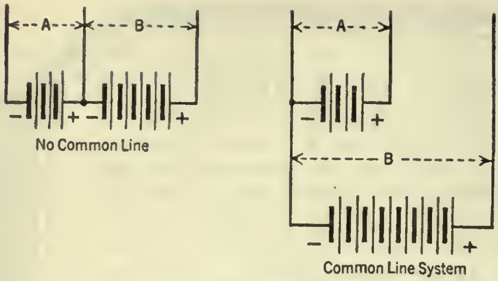


FIG. 6

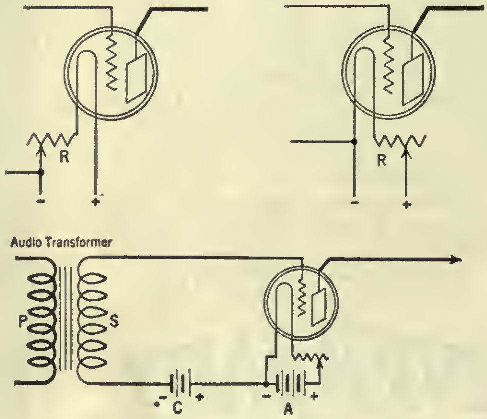


FIG. 7

difficult for the receiving station to pick up the wave of the transmitter.

In Fig. 4 the coils A, B and C comprise a standard vario-coupler redesigned as to winding in the manner shown in Fig. 5. The coil A consists of 50 turns of No. 18 d. c. c. wire, B 10 turns of the same wire and C 36 to 40 turns of any size wire from No's. 26 to 18. It will be necessary to experiment with the exact number of turns for C so that smooth control of regeneration is obtained over the entire wavelength band. Tuning is controlled by the variable condenser in series with the antenna. Its capacity rating is .001 mfd. With the key in the position shown, the circuit operates as a receiver but when the key is depressed it opens the phone circuit, closes the plate circuit and operates the apparatus as a transmitter.

Undoubtedly with the advent of the recent activity in short wave transmission this circuit will prove exceedingly interesting for experimentation.

NEEDED REFORM IN RADIO STANDARD PRACTISE

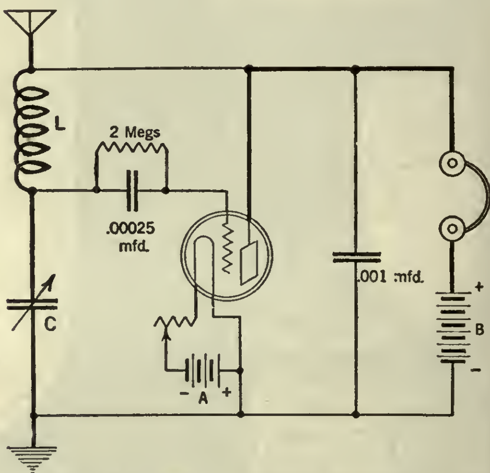
WITH something like 250 manufactured sets gracing the radio market and easily a like number of circuits for home construction, the need for standardization of circuit and connection methods becomes appallingly imperative. The question of A and B battery connections is only one of many but is the main subject of this discourse.

Many of the present circuits connect the plus A and B negative terminals together. Aside from adding a few more plate volts potential in the plate circuit, there is no other reason for this special method of connection. It is not an advantage and is decidedly a disadvantage for the following reason.

First, it is an electrical common practise to have a power circuit with part of it at ground potential. At least there is a common lead which serves as a base for meter reading.

Obviously it is impossible to make the positive leads (for instance of A and B batteries) common, so the most natural thing and advantageous method would be to make the negative sides common. See Fig. 6. This system would greatly facilitate meter reading of A and B potentials by merely flipping a switch. It would also make the reading of circuit diagrams easier.

Another desirable point of standardization lies in the placement of rheostats. Tube manufactur-



600 Meter Traffic	L = 100 to 150	Turn	Honeycomb	Coil
1200 - 2600 λ "	L = 300 to 400	"	"	"
2600 - 5000 λ "	L = 750	"	"	"
5000 - 15,000 λ "	L = 1500	"	"	"

FIG. 8

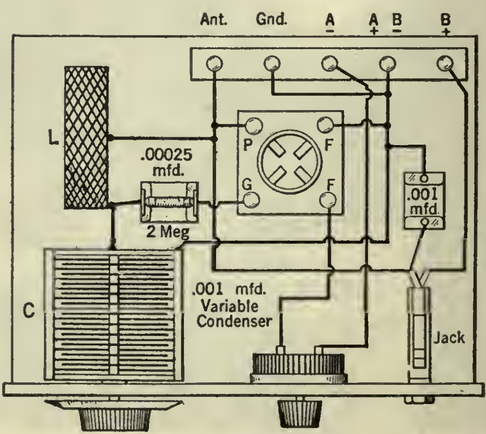


FIG. 9

? ? ? ? ? ? ? ? ? ? ? ? ?

You are planning to build a radio receiver and you want to know what kind to make. Shall it be a one-tube reflex, or a four-tube ultra-sensitive tuned and neutralized radio-frequency receiver using regeneration and push-pull amplification? The book which will satisfy the needs of every radio constructor, Radio Broadcast's Knock-Out Receivers, contains instructions on how to build these—in fact it tells how to make eight separate receivers.

Every purse and every desire is satisfied in the collection of receivers described in this book. Each one of the receivers was developed through the coöperation of Radio Broadcast, and thousands of radio enthusiasts all over the country have built these sets with the greatest of satisfaction.

There is no better group of receivers from which to pick the type to build than those contained in RADIO BROADCAST'S KNOCK-OUT RECEIVERS because they have been designed by experts to fit the need of the broadcast listener. All of them can be built from standard parts.

Complete information is contained in the book (which has one hundred pages), for building these receivers, but no blue prints can be sold with it. Well known radio authors like Walter Van B. Roberts, Zeh Bouck, Kenneth Harkness, John B. Brennan, and others have written the descriptions. This book is now being printed and deliveries will be made at once. It will be sent to any address on receipt of $1.00.

DOUBLEDAY, PAGE & COMPANY,
Garden City, New York

Please find enclosed $1.00 for Radio Broadcast's Knock-Out Receivers to be sent to

NAME

RBA ADDRESS

ers advise placing a rheostat in the negative side of the filament supply so that a negative grid bias may be obtained.

With the use of C batteries for biasing there is no reason for not placing the rheostat in the positive lead which is the more practicable. See Fig. 7.

CODE INSTRUCTION

FOR learning the code by one's self there is nothing better than memorizing the characters and then listening-in on long wave transmission. And the surprising thing about it is that it can be done with a single tube. The American Radio Relay League's publication, QST, outlines in its March and June, 1925, issues a receiver satisfactory for just such purposes.

With a single honeycomb coil, variable condenser, tube, socket, rheostat and batteries (antenna and ground also) it is possible to listen in on NSS, Annapolis, 17,000 meters; YN, Lyons, France, on 15,100 meters; KET, Bolinas, California on 13,345, and so on down the scale.

Some of these stations transmit slowly, repeating each word so that after one becomes proficient here he may jump down to the faster lanes of ship to shore traffic.

The circuit of the receiver is shown in Fig. 8 and the layout of the parts in Fig. 9. A 1-inch board 8 inches wide and 12 inches long is suitable. A panel 7 inches high and 12 inches long allows for the mounting of the condenser, rheostat and jack. Wire with bus wire for permanency. For additional information on this receiver it is well to consult the issues of QST mentioned above.

Before You Write to the Grid

THOUSANDS of you are writing the Grid for technical advice every month. The expense of framing a complete and exhaustive reply to each letter is very high. The editors have decided that the benefit of the questions and answers service will continue to be extended to regular subscribers, but that non-subscribers will be charged a fee of $1 for each letter of inquiry which they send to our technical department. Very frequently, our technical information service proves of definite money value to you who write us, for we are often able by a sentence or two of explanation, to put you on the right path before you have made a perhaps expensive mistake.

The occasional reader of Radio Broadcast will be charged a fee of $1 for complete reply to his questions, and the regular subscriber can continue to take advantage of the service as before. In that way the non-subscriber will help share the cost of the technical staff whose service he gets. Every letter receives the benefit of the experience of the editor and the technical staff and every correspondent may be sure that his questions will receive careful consideration and reply.

When writing to the Grid, please use the blank printed below.

GRID INQUIRY BLANK

Editor, The Grid,
Radio Broadcast,
Garden City, New York.

Dear Sir:

Attached please find a sheet containing questions upon which kindly give me fullest possible information. I enclose a stamped return envelope.

(Check the proper square)

☐ *I am a subscriber to* Radio Broadcast. *Information is to be supplied to me free of charge.*

☐ *I am not a subscriber. I enclose $1 to cover costs of a letter answering my questions.*

My name is ____________________

My address is ____________________

G. A.

WHERE RADIO IS NOT SIMPLY "FURNITURE"

A farmer's home in central Iowa, where the radio receiver is a vital part of the home equipment. Farmers have found market reports a direct financial help to them during the daylight hours. In the evening the farmers are some of the most interested of broadcast listeners. Radio is helping to solve the problem of how to keep the farmers on the farm

RADIO BROADCAST

Vol. 7 No. 5 September, 1925

Is the Radio Newspaper Next?

Newspaper Organizations Have Been Quick to Seize the Opportunity of Radio—How the News is Sent Ashore and Afloat—The Possibilities of the Tabloid Radio Newspaper

By JAMES C. YOUNG

THE future of the press lies in the air. Radio represents the one channel of news expansion not already developed to the full. When Fort Sumter was fired on in 1861, the Pony Express rode full tilt for a whole week to carry the news to California. Even then the telegraph wire, linked from pole to pole between skirmishes with Indians, was advancing across the continent. This was the eighth wonder of the world, surpassing all other wonders in the descent of man—a tiny thread of copper carrying sound unmeasured distances.

Then came the telephone. Its appearance was coincidental with the girdling of the globe by cable lines. But the last and greatest age of communication did not begin until three decades later, when crude instruments first feebly recorded wireless waves. The last ten years have served to improve radio to such an extent that man can instantly transmit his thoughts around the sphere.

Meanwhile the newspaper has also developed until now it has become a permanent record of modern life. What is said and done the world over finds expression in this record. The total number of words sent daily by telephone, telegraph and cable, between newspapers everywhere, would test the average man's imagination. Radio, the newest agent of the press, bears but a small part of this burden. On busy days, the word traffic between Europe and America will rise to 100,000 words. When business is dull this total falls off to 50,000 or even less.

But radio by no means is limited to the transmission of news between agents of the press. It is rapidly becoming a part of the press. We might call it an aërial edition and not be far in the wrong. More than fifty American newspapers send out bulletins at short intervals to the owners of radio sets both far and near, informing them of the latest decision of the British cabinet. That decision may not be half an hour old when some sheep herder in the backlands of Texas will learn that English labor has prevailed in its demands for better housing at state expense. Or the speeding waves of radio may convey word that Morocco is engaged in a new war. Even the gossip of Broadway and the last quotation on wheat are whisked around the world for all to hear.

This aërial edition of the press, usually issued every thirty minutes by the newspapers participating, offers possibilities which excel those of the established editions published daily by the great metropolitan plants. The instant communication of important matters to the whole body of mankind is now possible. Any great event that transpires to-day must

THE PONY EXPRESS

In the earlier days of national development was the chief means of communicating intelligence. The method was slow, not especially certain, and rather hard on the pony expressman. This old engraving shows an express relay station in the Rocky Mountains

be known within five minutes wherever men have ears.

THE INFLUENCE OF NEWS BROADCASTING ON THE PRESS

THIS new practice of instantaneous news broadcasting must essentially have a wide influence on the press. A dozen years ago the "extra edition" was the special marvel of the newspaper field. In some plants it was possible to produce such an edition within twenty minutes from the time of a world development. During the recent war these extra editions were almost an hourly event, particularly when the battle of the Marne hung in suspense and the Germans beat hard upon the door of Flanders.

Peace brought fewer editions and a steadier tone to the press. In the few years since 1918, radio broadcasting has developed so extensively and intensively that extra editions would lose much of their interest if the war were under way to-day. It might be argued that bulletins in front of newspaper offices whet the public appetite for news, instead of dulling its edge. But these bulletins are glimpsed by only a few thousands of people. And at best they are nothing more than skeletonized dispatches.

This is not the case with radio news broadcasting. When events justify, announcers inform a myriad listeners what has transpired. It is easy to read dispatches in full. Ordinarily news of the first rank arrives in short, pregnant messages. The man with a radio set may learn in the evening of some great event that his particular newspaper will not convey to him until the next morning. When an event of this kind is far distant—such as the Tokio earthquake—it frequently happens that a day or more will elapse before details begin to come through.

In view of all of these considerations, no one may doubt that radio is exerting a strong influence on the press, and the press certainly will have an equal bearing on radio. It would seem that the press has been somewhat backward in developing the possibilities of news transmission and broadcasting. Only a comparatively small group of American newspapers are using the international stations and there are but two press receiving stations in existence.

Publishers of small newspapers have found that radio broadcasting reduces interest in warmed over news. It is an old axiom of such newspapers that the scissors are mightier than the pen and seldom are the shears idle when a small paper is in the making. But the publication of matters already covered by some broadcasting station will not satisfy even country readers. The event may have been completed, perhaps wholly reversed, by the time that these papers appear.

Therefore small papers are beginning to suffer from radio competition. Even the papers in large cities will feel the stress of this competition as it expands. But we may be certain that the newspaper is a fixed institution. Although it may lose some of its claim to freshness, when news broadcasting becomes general, it will have wide opportunity to amplify and develop news. In a measure, the newspaper is likely to evolve along the lines of established magazine practice, departing somewhat from the breathless, last minute attitude that marks such a large section of the press. If that evolution ever comes about, it will bring a large measure of relief to an abused public. We may conceive of the day when no paper can print such headlines as this one—"Burglar Slays Widow; Flees With Jewels"—for the excellent reason that it will be "old stuff." When the next edition comes out the burglar may be in jail, by the help of radio.

THE EFFECT OF THE WAR

AFTER the Armistice, radio development received a new stimulus. But it also lost in momentum because of the lessening of concentrated attention by the world's best

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A CALIFORNIA STAGE COACH

Navigating a mountain road. The article by Mr. Young draws an interesting parallel between the present almost instant methods of spreading news, seconds after it is news, and the infinitely slower methods available to our great-grandfathers

inventive brains. For a year or two the whole subject was vague and uncertain. Transatlantic service was bad. So the New York *Times*, always among the leaders in news enterprise, determined to install its own station. This station first went into use in 1920, becoming the example and cornerstone for all latter day developments. In the beginning it was largely an experiment, and the experimental spirit has continued to dominate its operation.

The New York *Times* has been called a war paper, because much of its prestige resulted from the thoroughness of its dispatches from 1914 to 1918. In the language of newspaper men, the *Times* "covered the war like it covered Harlem." The coming of peace left so many problems unsettled in Europe that prompt, dependable radio service was a necessity for the continuance of this policy. The station has been equipped for the widest range of transmission. Its daily news report averages about 10,000 words, and these messages can be recorded from three stations simultaneously, on wavelengths of 50 to 25,000 meters. Some of these dispatches literally are sent around the world.

How such enterprise may be rewarded was indicated not long ago when the *Shenandoah*, the Navy's big dirigible, broke from her mooring mast at Lakehurst, New Jersey, and went careening away in a wild storm. The Navy already had lost two dirigibles, both by explosions, with heavy loss of life. Seemingly another tragedy impended. But word scarcely had been flashed from Lakehurst when the *Times* station picked up the *Shenandoah's* call and learned that all was well, the big ship plunging along in the gale, embarrassed but safe.

This event took place just about the hour that the *Times* was going to press. The news was duly printed on the first page, giving the paper a "beat" such as seldom falls to any publication in this day of news organization. The *Times* station also has been first with a number of sos messages and it figures daily in the dissemination of world news.

NEWSPAPERS INSTALL A JOINT STATION

PLAINLY the early success of the *Times* with radio dispatches was not to go unobserved. The American Newspaper Publishers Association, working through a special committee, determined to experiment with radio transmission. The *Times* and the Chicago *Tribune* have been prominent supporters of the plan, which resulted in the erection of a station at Dartmouth, Nova Scotia, for transatlantic work. This station is just across the bay from Halifax and affords the advantage of acknowledging radio dispatches by means of the imperial cable ending at Halifax.

In February of 1922, the station began operation and now is in direct communication daily with four of the big plants in Europe, those at Leafield, and Northolt, England, Lyons, France, and Coltano, Italy. A new station is now under construction near by for the retransmission of dispatches which come to Dartmouth. So far the traffic has been handled by telegraph and telephone wires, but it is planned to send the news direct to subscribers from the new plant.

This Dartmouth station and that of the *Times* work in close coöperation, one relieving the other when storms or other causes render reception difficult. The two of them would seem to have proved that radio transmission across the Atlantic is a thoroughly practical undertaking for private newspaper organizations. Such plants also afford some measure of protection in the despatch of news which may have great value. It is to be believed that the next year or two will witness further enterprise in this direction.

The New York *World*, also interested in the Nova Scotia plant, has conducted wide experiments in the transmission of photographs by radio. This subject has had attention from the *World* for several years and the photographs already received warrant belief that the *World* may install a station one of these days exclusively for the purpose of transmitting radio photographs.

Extensive experiments have been conducted by the International News Service, one of the Hearst organizations, for the purpose of automatic reception and elimination of static, doubtless with the view to installing a trans-

THE TRANSATLANTIC NEWSPAPER RADIO STATION

At Halifax, Nova Scotia, as it looked under construction in 1922. J. A. Burch, engineer, and F. E. Meinholtz, chief operator, New York *Times*, are seated, left to right. This station is maintained by a syndicate of about nine of the largest newspapers in the United States purely to receive press messages addressed to it from foreign countries. The messages are then forwarded to the supporting newspapers by the usual methods. Little transmitting is done from this site except to acknowledge messages and to get corrections. A power of about ten kw. is employed

atlantic station when conditions warrant it. These four news organizations have the radio field practically to themselves.

In the matter of broadcasting, first honors fall to the Chicago *Tribune*, which introduced the half hourly bulletin now sent out regularly from WGN in Chicago. The *Tribune* operated its own plant for a time but later determined to use one of the commercial stations. Its bulletins are well known to a large section of the American public, furnishing a brief survey in terse language of just what is going on in the world. The bulletins sent out by the Radio Corporation of America also are copied on ships in the seven seas. Some of the big passenger vessels, maintaining their own printing plants, reproduce these dispatches in the form of miniature newspapers which are distributed every day the traveler is aboard. On other ships, lacking this pretentious equipment, they still constitute a tie with the world of affairs which lies behind and before.

KYW, also in Chicago, broadcasts the bulletins of the local Hearst papers, which further inform the public of the activities of its neighbors whether they happen to live in the next county or on the next continent. Even secret treaties and whispered understandings have drifted into this great hopper of news. Radio now supplements the press in disseminating such information everywhere. The man who runs need not pause to read. He can listen as he goes and take with him a concise, photographic mind picture of how the world is conducting itself.

MANY PAPERS BROADCAST NEWS

OTHER papers in many states are broadcasting news by radio, ranging from such diverse communities as Detroit to Fort Worth. It is an odd phase of New York journalism that none of the country's greatest papers so far have embarked in news broadcasting. But the practice is growing daily, notably in cities of the 200,000 class, where life is not quite so busy as in the big centers, and people presumably have more time to heed the world's gossip. It is even said that farmers' wives have quit listening on the party line when Mrs. Jones calls up the grocer, preferring to get the latest word from Paris about this season's dresses. Radio news is broadly diversified, as it should be. It is a noticeable reflection of the daily newspaper. First comes the "leader," the big story of the hour. Then the other news in a descending scale. Occasionally there is an editorial squib. The sports department, ordinarily the last in rank, frequently enjoys a larger number of minutes than all of the other departments joined together. The public may or may not care about the British cabinet decision and the new

THE RADIO ROOM OF THE NEW YORK "TIMES"

Here, operators are constantly on duty receiving press messages addressed to them from their correspondents abroad. A watch is also kept on the various commercial wavelengths. In that way, news is transmuted almost instantly from the air to the printed page. The *Times* has been able to score many news "beats" through the enterprise of their listening radio operators. F. E. Meinholtz, chief radio operator of the *Times* is standing, and R. J. Iveson is seated at the typewriter. The apparatus on the long table is devoted almost entirely to receiving from European stations on wavelengths of 10,000 meters and above

war in Morocco, but it always wants to know whether Babe Ruth has knocked another homer and if it really is true that poor old Ty Cobb has a "charlie horse" and must quit the game.

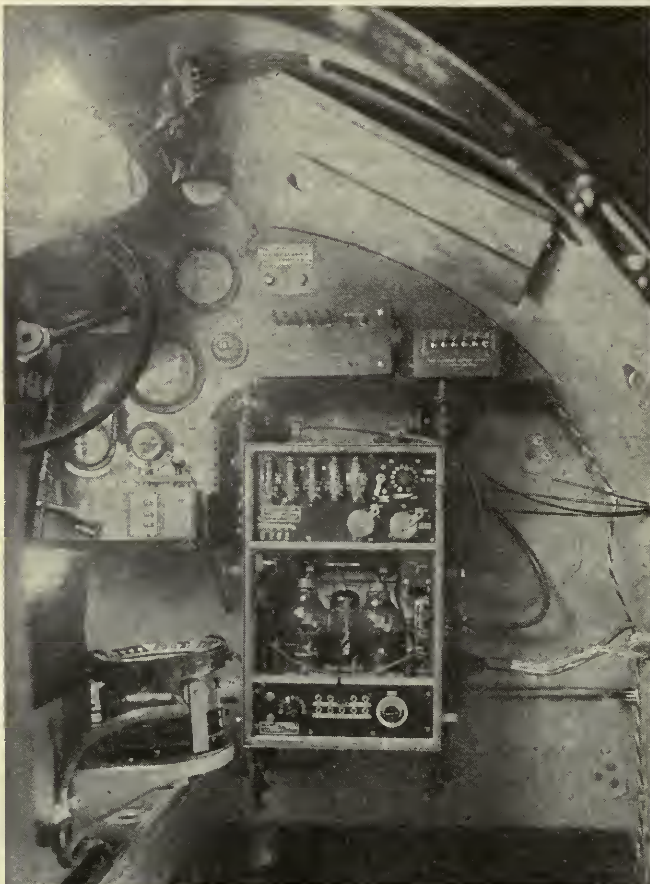
If the moralist wished to seek a lesson from the example the preponderance of sports news over other kinds, as broadcasted in the great radio press, he might find a number of interesting suggestions. For one thing, Americans are a vigorous people, with a strong leaning to the dramatic. Since Mr. Ruth and Mr. Cobb are the very essence of our national drama, the average radio user is deeply interested in their home runs and "charlie horses."

Another thing worth considering is the fact that sports news was the first of any kind to be sent out by radio. Baseball, football, and the prize ring lead where the serious figures of news and editorials are now beginning to follow.

It does not take much imagination to call up the day when we shall get a complete newspaper by radio read to us by a specially trained voice. Life is to be made a little simpler for the man who works all day and says he is "too tired to read the paper to-night." Before long he may have it read for him by a man who knows how, a man who will study his tastes and reactions with the skill of an actor.

Doubtless, our mentor not only will read us the news and the editorials and all about the baseball team, but maybe he will have a comic strip of his own, and we can imagine the funny little figures while he reads the captions. Then we also may expect a column of wit, written to order every day, never repeating a joke older than that one about the Irishman who carried bricks up the ladder while the man on top did the work.

Such is to be the radio newspaper of to-morrow, or something approximating this brief glimpse. Perhaps it will have a fashion column and the busy housewife can note down the sizes and descriptions of new dresses. Conceivably the cross word puzzle will be a feature if the fad lasts much longer. We could draw our own squares and spend the rest of the night happily, after the announcer gave us a few instructions. In fact, the radio newspaper may be made almost anything that the public wants. Whatever this evolution is destined to be, the radio newspaper has become an accomplished fact. And certainly there is the call now for the latest bit of news.



NEWS FROM AIRPLANES

Is being forwarded by radio. Both means have been most successful in impressing the present generation with the speed with which news is gathered and disseminated. The photograph shows a radio transmitter and receiver installed aboard one of the latest types of British airplanes belonging to the British Imperial Air-ways and used in cross-channel passenger and freight flights. This is the first photograph to reach this country of the interior of the control equipment of these planes, and is one of the few good photographs in existence of an airplane interior

An All-Wave Tuned Radio Frequency Receiver

How to Build an Efficient Receiver With High-Quality Audio Amplification, Designed to Cover the Frequency Band from 1500 to 116 Kilocycles (200 to 2600 Meters)

By ZEH BOUCK

¶ *THIS receiver embodies no especially new circuit ideas, but it forms a very valuable acquisition to the receiving equipment of the experimenter who wishes to hear signals on other waves that those alloted to broadcasting in the United States and near-by countries. In France, England, Australia, and Germany there are broadcast stations transmitting way above the conventional wavelengths, and many American listeners have expressed a lively interest in hearing signals from those broadcasters. The use of resistance-coupled amplification insures excellent quality in the audio part of this circuit. And, too, for those broadcast listeners who are beginning to be curious about what is going on in radio telegraph channels, this set will give them a good frequency band from which to choose their signals. They can hear much traffic between ships at sea and shore stations and some amateur communication as well.*—THE EDITOR

UNLIKE American stations, foreign broadcasters are not confined to the frequency band between 1500 and 520 kilocycles (200 to 575 meters). On the contrary, many foreign stations, particularly those of continental Europe, broadcast on frequencies below 500 kilocycles (above 600 meters), as well as upon the wavelengths with which our domestic amateurs are familiar. This elasticity of tuning somewhat complicates the situation of the foreign enthusiast, whose problems were recently brought home to the writer by the request of a Belgian friend for a receiver filling these particular requirements.

The set is to be operated at Turnhout, Belgium, some three hundred miles from SBR Brussels, the nearest broadcasting station, and about seventy-five miles from Antwerp. As the radio entertainment of my friend's family will be divided between England and the continent (and perhaps American stations), the receiver must respond with equal efficiency over a comparatively large frequency band—between 1500 and 116 kilocycles (200 to 2600 meters).

It is, of course, difficult to design an efficient receiver to cover this band employing one permanent set of inductances, i. e., using sufficiently large coils to attain the higher waves, and tapping for the lower waves. The losses and inefficiencies attending such extensive tapping would seriously impair the effectiveness of the receiver on the higher frequencies (lower waves).

Honeycomb coils suggest themselves in the usual three coil, primary, secondary, and tickler arrangement, as an obvious solution. Unfortunately, the wide separation of foreign stations implies the necessity of at least one stage of radio frequency amplification if consistent reception of four fifths of the stations is to be achieved. The efficiencies of the honeycomb coils in the conventional long wave circuits, however, are quite applicable to radio frequency amplification, and the ultimate receiver almost solves its own problems in the form of a "five honeycomb coil set."

With the growing stimulation of interest in international broadcasting and its reception, it is probable that many American enthusiasts will be interested in duplicating this receiver.

HONEYCOMB INDUCTANCES ARE USED

THE circuit is diagrammed in Fig. 1. The coils L are all honeycombs. L_1 is the antenna primary, and L_2 secondary inputting to the r. f. tube. L_3 functions as the primary of the radio-frequency transformer. L_4 is the r. f. secondary in the grid circuit of the detector tube, and L_5 is the tickler coil. It will be observed that the circuit is merely the conventional three-coil arrangement with the addition of a stage of tuned radio frequency

amplification. In changing wave bands, the coils in each of the five mounts are replaced by different sizes. By selecting the proper values, any frequencies used to-day for transmission of radio telephony or telegraphy can be received.

Returning to the circuit, switch S_1 is the usual series-parallel switch which adds considerably to the tuning possibilities of the antenna tuning-condenser C_1. C_1 is preferably a forty-three plate variable condenser. C_2 and C_3 are secondary tuning variable condensers each having a capacity of .0005 mfd. C_4 is a .006 mfd. Micadon by-pass condenser. C_5 is a .0025 mfd. bypass. C6 is the usual .00025 mfd. grid condenser. C7, C8, and C9 are the isolating-coupling condensers of the resistance-coupled amplifier, all being Micadons of .006 mfd. capacity. C10 is an output bypass condenser, capacity .006 mfd. which may or may not be necessary in individual receivers.

R_1 is a three hundred- to four hundred-ohm potentiometer which stabilizes the r. f. circuit. R_2 is the conventional 2-megohm grid leak across the grid condenser. R_3 is a General Radio ten-ohm rheostat. R_4 is a dismantled twenty-ohm rheostat placed in series with the small three-volt pilot lamp, PL. This lamp is located behind a colored glass jewel on the panel and is an effective and attractive signal that the tubes are burning. It is not, of course, essential to the operation of the receiver. R_5 throughout the resistance-coupled amplifier represents the coupling resistors of one hundred thousand ohms resistance. R6, R7, and R8 are amplifier grid leaks, having respective values of 1 megohm, $\frac{1}{2}$ megohm, and $\frac{1}{4}$ megohm.

The coupling resistors, coupling condensers, and amplifying tube grid leaks are combined for efficient compactness into three Daven Resisto-Couplers. Daven resistors are used throughout the amplifier. The initials on the diagram represent the initialing on the couplers.

J_1 is a standard closed circuit jack, placed in the plate circuit of the first audio frequency tube. This is preferable to plugging-in on the detector. Jack J_2 is an open circuit jack with filament control. Switch S_2 turns on all filaments when the loud speaker plug is in jack J_2, and the first three tubes with the plug is in jack J_1.

The 4.5-volt C battery while not altogether necessary, is desirable. Particular note should be taken of the amplifier grid leak connections.

LIST OF PARTS

THE circuit diagram, Fig. 1, represents the following parts used in the construction of the receiver:

One three coil Branston Mounting
Two Cotocoil mounting brackets
5 Na-ald Sockets
2 .0005 mfd. variable condensers
1 .001 mfd. variable condenser
1 Midget vernier condenser (across C_3)
1 series parallel switch
1 Cutler-Hammer battery pull switch
1 General Radio ten-ohm rheostat
1 400-ohm General Radio potentiometer
1 .00025 mfd. Micadon
5 .006 mfd. Micadons
1 .0025 mfd. Micadon
4 Daven grid leak resistors, 2 meg., 1 meg., $\frac{1}{2}$ meg. and $\frac{1}{4}$ meg.
3 Daven 100,000-ohm coupling resistors,
1 7-inch x 21-inch bakelite panel
3 Daven Resisto-Couplers
8 Eby binding posts
1 Pacent closed circuit jack
1 Pacent open circuit, filament control jack

These parts represent an approximate cost of thirty-five dollars. To this price must be added the expense of whatever honeycomb coils are selected for reception of various frequencies.

CONSTRUCTION

THE constructional details of the all-wave receiver are clearly suggested in the panel layout, Fig. 3, and in the photographs of the completed receiver, Figs. 2, and 4.

Referring to the back of panel photograph, Fig. 2, the Cotocoil single honeycomb coil mountings are screwed to the baseboard near the right hand (rear view) end. Coils L_1 and L_2 are plugged into these receptacles. Partly hidden and to the right of the coils a resistance strip from a rheostat can be discerned, fastened to the baseboard. This is placed in series with the small three-volt pilot lamp as described in reference to the circuit diagram.

The pilot lamp itself is screwed into a small miniature socket from which the porcelain shell has been removed. It is placed beneath the antenna tuning condenser, and the glass jewel can be seen in the lower left of Fig. 4.

The large dial controls, in the panel photograph Fig. 4, are, left to right, tuning condensers, C_1, C_2, and C_3. The lower left is the series-parallel switch. The upper right hand knob is the midget vernier condenser across the tuning condenser C_3. Below the vernier is the potentiometer.

In wiring the receiver, particular care should

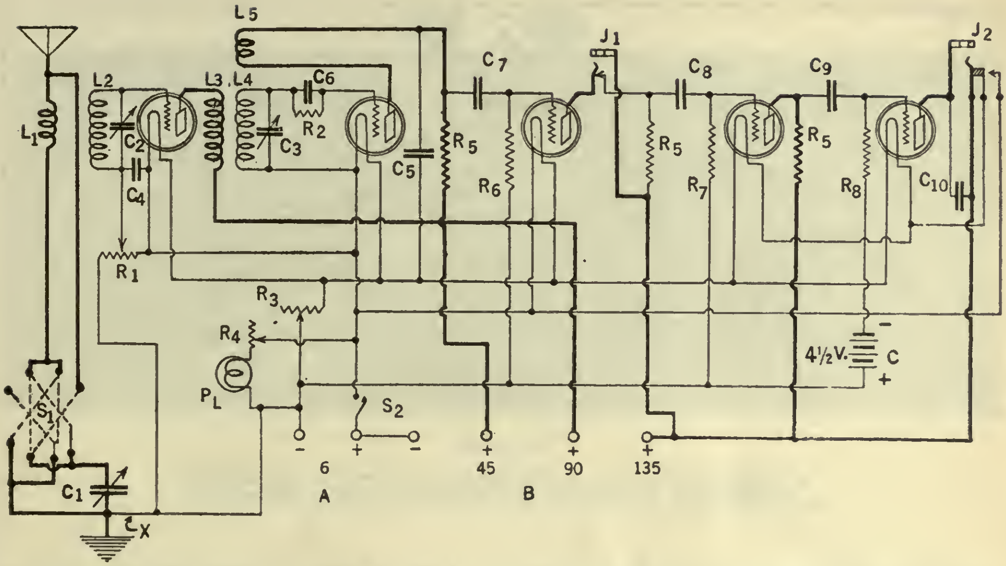


FIG. 1
The circuit diagram for the all-wave tuned radio frequency receiver

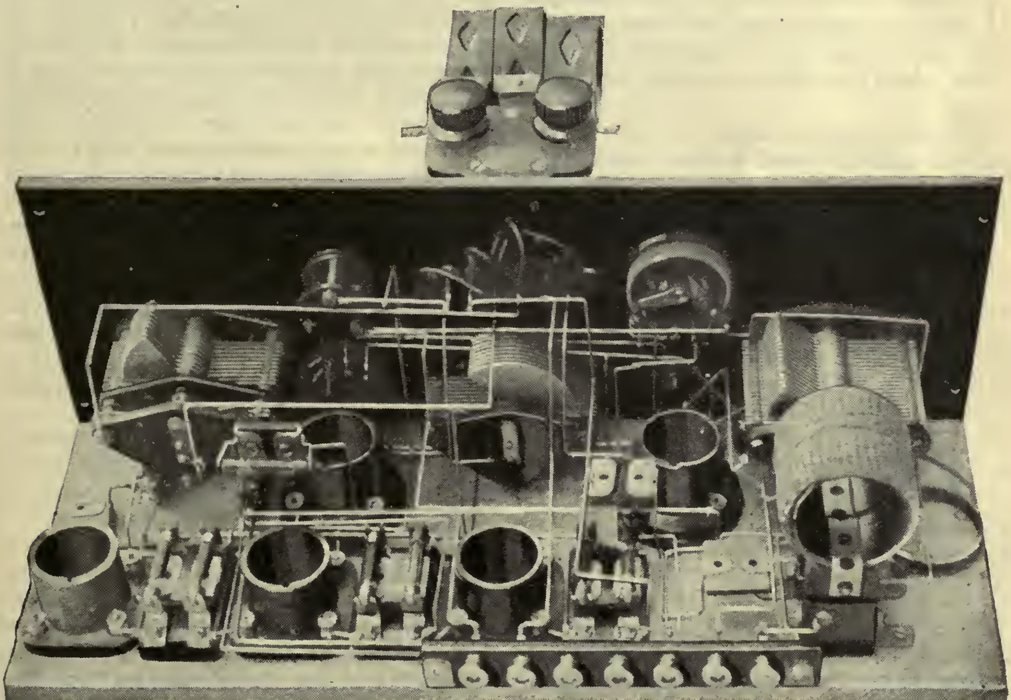


FIG. 2
Back of panel view of the all-wave set showing construction of the resistance-coupled amplifier and the mounting of L1 and L2

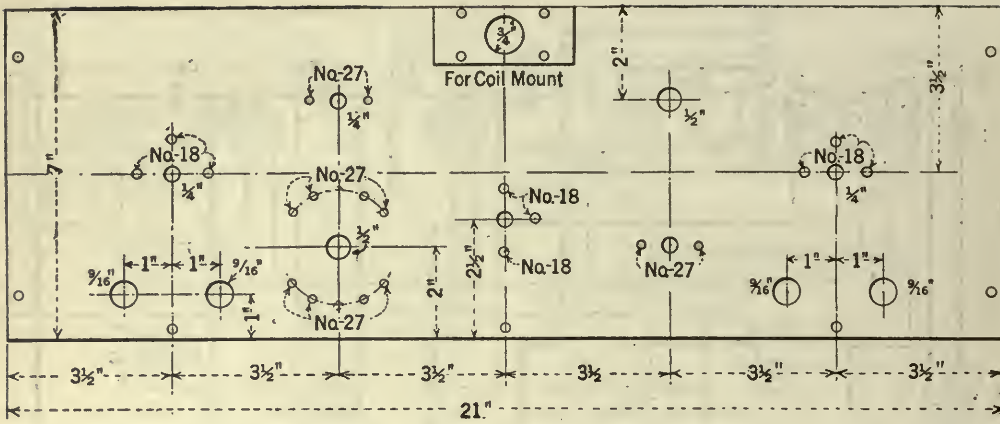


FIG. 3

The panel layout for the universal receiver. The numerals near the designated holes indicate the size drills to be used in drilling them

be observed in making connections between the A battery and the various tubes, resistances, and switches, being careful to follow every sequence on the diagram.

OPERATION

TUNING and operation of the receiver is quite the same as that of the conventional three honeycomb coil arrangement with the slight added complication of an extra control.

The following is a table of coil sizes for the various domestic and foreign broadcasting wavelengths:

L_1	L_2	L_3	L_4	L_5
1500 to 600 kilocycles (200-500 meters)				
35	50	35	50	75
665 to 334 kc. (450 to 900 meters)				
100	100	50	100	120
483 to 272 kc. (620 to 1100 meters)				
100	150	75	150	150
272 to 115 kc. (1100 to 2600 meters)				
150	250	150	250	200

Unfortunately, the receiver I am describing was not in my hands sufficiently long to determine coil values for still higher waves. It is suggested that the experimenter guide himself by the sizes specified for the conventional three-coil long wave receiver.

There is also no reason why the all-wave receiver, efficiently constructed, should not be quite satisfactory on the extremely short waves—the region of megacycles. With Lorenz coils wound on a three-inch form, with fifteen spokes, the following sizes should cover from 40 to 70 meters. L_1 3 turns, L_2 6 turns, L_3 5 turns, L_4 6 turns and L_5 11 turns. On these extremely high frequencies, it is recommended that capacity neutralization be substituted for bias stabilization, with the potentiometer. A three-turn neutralizing coil should be wound simultaneously with L_3, and connected as in the usual Roberts or Browning Drake arrangements. It is suggested that experimentation on wavelengths below two hundred meters be left to the more advanced and serious experimenter and amateur. The manipulation of the receiver on these frequencies requires more than ordinary skill, and even a comparatively non-radiating receiver, such as we have described is not innocuous under inexperienced operation.

In operating the all-wave receiver, the potentiometer should always be kept sufficiently far on the positive side to stabilize the r. f. tube.

Selectivity will be increased as coupling is loosened between L_3 and L_4, as is usual with honeycomb receivers. Loosening this coupling will also increase the effectiveness of the r. f. controls. If situated within a mile or so of a high powered station, interfering oscillations may force themselves across the radio-frequency circuits. Breaking the connection close to the ground lead at X, Fig. 1 will eliminate such by-passed interference.

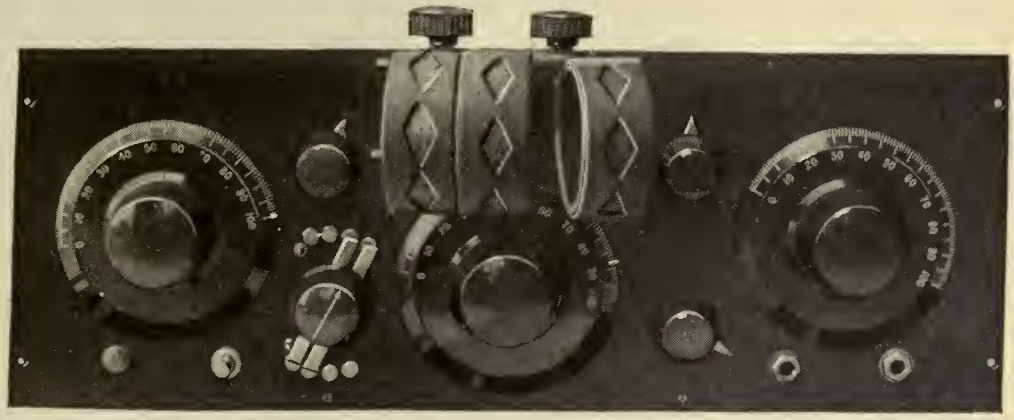


FIG. 4
Front view of the completed receiver. The two honeycomb coils to the left function as a tuned radio frequency transformer

HIGH-MU TUBES IN THE LAST AUDIO STAGE

IT IS recommended that five-volt vacuum tubes be used throughout the receiver. They will give excellent loud speaker results on distant stations with a good antenna. However, if high-mu tubes (there are several makes on the market) are available, they can be employed most effectively in the first and second stages of the resistance-coupled amplifier. A power tube (never a high-mu tube) in the output socket will increase the possible volume without distortion. If the output is taken from jack J_1 a standard tube should be used in the first resistance-coupled stage.

The tuning characteristics of the all-wave receiver are most satisfactory, providing selectivity and distance, while the resistance-coupled amplifier insures quality beyond reproach.

The following is a list of long wave broadcasting stations:

Foreign Broadcasting Stations

Australia:
- 2FC, 272 kc. (1100 meters)
- 2FL, 389 kc. (770 meters)
- 3LO, 174 kc. (1720 meters)
- 5MA, 352 kc. (850 meters)

Austria:
- RH 500 kc. (600 meters)

Belgium:
- BAV, 272 kc. (1100 meters)

Czecho-Slovakia:
- OKP, 260 kc. (1150 meters)
- Komarov 167 kc. (1800 meters)
- Prague, PRG, 300 kc. (1000 meters)

Denmark:
- OXE. 130 kc. (2400 meters)

France:
- FL, 115 kc. (2600 meters)

Germany:
- LP, 440 kc. (680 meters)

Holland:
- PCGG, 280 kc. (1070 meters)
- PA5 286 kc. (1050 meters)
- PCFF 150 kc. (2000 meters)

Hungary, Buda Pesth:
- 150 kc. (2000 meters)

Spain:
- EBX, 250 kc. (1200 meters)

Switzerland:
- HBI, 272 kc. (1100 meters)

When Broadcast Stations Interfere

An Explanation of "Heterodyne" Interference Produced By Broadcast Stations—What the Department of Commerce Is Doing to Minimize the Difficulty—How the Listener Can Aid

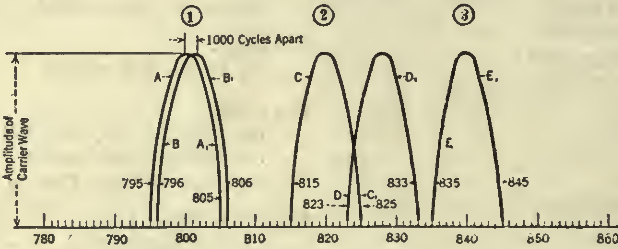
By C. B. JOLLIFFE

Physicist, Bureau of Standards

FOR more than a year, Radio Broadcast *has been printing informative articles about how various kinds of interference troublesome to the broadcast listener may be traced, reduced, or altogether conquered. Among the first of these was a series on "Man-Made Static" by A. F. Van Dyck, the first of which appeared in this magazine for April, 1924. In the July* Radio Broadcast, *there were two articles, one by John V. L. Hogan and the other by Dr. Alfred N. Goldsmith, which told how to use single-circuit receivers without annoyance to one's neighbors. This article, which is published by permission of the Director of the Bureau of Standards of the Department of Commerce, tells how the steady squeals produced by any two broadcast stations which are heterodyning each other occur, and the efforts being made by the Department of Commerce to lessen this rather unusual form of interference.*—The Editor

AT TIMES, when tuning-in a broadcasting station, there is heard in the receiving set a whistling sound whose pitch (frequency) cannot be changed no matter what is done to the controls of the set. As the tuning adjustments are changed, the whistle reaches greatest intensity at one point on the dials and dies away gradually as they are turned from this tuning point. The fact that the note remains the same pitch distinguishes it from the whistle of varying pitch ("birdies") produced by your own or some other person's generating (oscillating) receiving set.

If the tuning controls are turned slowly while one listens carefully it will usually be found that there are two stations which can be heard very close together when the whistle is at its maximum loudness. These two transmitting stations are "beating" and producing the whistle. Let us take, for example, two stations that are on frequencies of 800 and 801, kilocycles per second (wavelengths 375, and 374.5 meters). Signals from both of these stations enter the receiving set and in addition to giving up to the set the messages (music, etc.) which they carry, the radio-frequency currents produced by the carrier waves combine and produce a note which has a frequency equal to the difference between the frequencies of the two received waves, in this case 1000 cycles per second. This is a high-pitched whistle. Any two stations that are closer together than 3000 cycles will give a whistle which can be heard and which is very annoying. The frequency of the whistle



HOW BEAT NOTES ARE PRODUCED

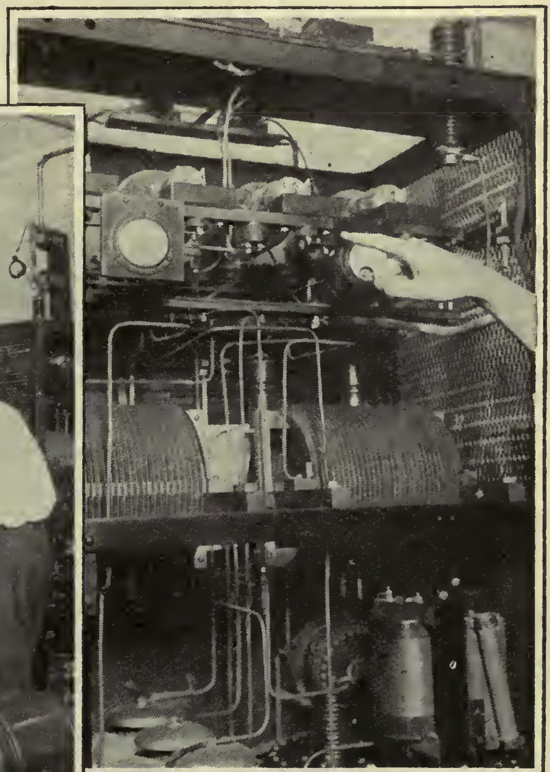
In No. 1 the curve A-A^1 covers a range of from 795 to 805 kilocycles with its peak at 800 kc. Curve B-B^1 with its peak at 801 kc. covers a band of 796 to 806 kc. The beat is equal to the difference of the two—in this case 1,000 cycles. In No. 2 we have a less pronounced example. Here the peak of C-C^1 is at 820 kc. while that of D-D^1 is at 828. Since the transmitted wave is assumed to cover a band 10 kc. wide it is obvious that there will be an overlapping. The difference here is 8 kc. or 8000 cycles. Example No. 3 shows no overlapping and no beat is produced. It is possible in some instances where there is overlapping that the difference is so great as to produce a beat above the frequency range which the human ear can hear

is always the difference in the frequencies of the waves of the two beating stations.

The assignment of frequencies (wavelengths) which is made by the Department of Commerce to the transmitting stations is such that no two Class B stations operating simultaneously should be closer in frequency than 10,000 cycles. Two stations having a difference in their frequencies of 10,000 cycles produce a beat note which is too high to be readily audible. So if all Class B broadcasting stations maintain accurately the frequency which they are legally entitled to use they would produce no beat interference. These Class B stations are the ones to which the large majority of the people listen and are assigned frequencies between 550 and 1000 kilocycles (wavelengths 545 to 300 meters)

WHAT THE RADIO SUPERVISORS ARE DOING

THE radio supervisors are continually checking and adjusting the frequencies of the stations in their districts and making an effort to keep them exactly on their assigned frequencies. A transmitting station, however, requires constant inspection of its frequency for its operators to be sure that it remains constant. The supervisors are unable to give this much attention to a single station since there may be several hundred stations (broadcast, amateur, commercial, etc.) under the jurisdiction of one supervisor and his two or three assistants. It has been recommended that all broadcasting stations require and use an indicating instrument which tells them



HOW THE BROADCAST STATION CHECKS ITS WAVELENGTH

With the wavemeter, which the operator is adjusting here, it is possible to know whether the broadcasting station is complying with government regulations and transmitting on the wavelength assigned to it. In the photograph at the right, the hand is pointing to chokes in the radio frequency circuit. Sometimes in an oscillating circuit there are harmonic frequencies set up besides the fundamental frequency on which the station operates. To eliminate harmonic frequencies, choke coils resonant to these frequencies are employed to absorb them. Incidentally here is shown a very good example of the compact and rugged construction of the transmitter proper

when they are exactly on their assigned frequencies. Specifications for an instrument for this purpose have been prepared by the Bureau of Standards, and it has been put in use in several broadcasting stations after being set at the Bureau. This device has been found to be a valuable help in maintaining the stations on their proper frequencies.

During the past year, the Bureau of Standards has also been active in assisting the supervisors of radio in setting the broadcasting stations to their assigned frequencies and keeping them there. The Bureau of Standards has occasionally made simultaneous measurements with various supervisors on broadcasting stations to determine the frequency of the station or to check the setting made by the supervisors. This also serves as a check on the accuracy of the supervisor's wavemeter. Twice each month, standard frequency signals are sent out by the Bureau which can be used by the supervisors of radio as well as others to calibrate their wavemeters.

In addition to the measurements requested by the supervisors, the Bureau has made frequency measurements on many broadcasting stations. The results of these measurements are furnished to the supervisors and tell them what stations in their district are varying from their frequency and producing beats or likely to do so. Some of the supervisors of radio are also equipped to make frequency measurements on distant broadcasting stations at their office. These measurements show that there are a few stations which have maintained their frequencies very accurately for nearly a year; in fact, so constant that they have been announced as standard frequency stations suitable for use for wavemeter calibration. These stations are announced each month in the Radio Service Bulletin, a publication of the Department of Commerce. The price is 25 cents a year and orders should be placed with the Superintendent of Documents, Government Printing Office, Washington, D. C. The constancy of these stations demonstrates that if special care is given by the operator, a transmitting set can be adjusted to its assigned frequency and be kept there over a long period of time.

HOW THE RADIO SERVICE HELPS ELIMINATE INTERFERENCE

THE work of the supervisors of radio, assisted by the Bureau of Standards, in setting and maintaining the frequencies of Class B broadcasting stations has been very successful. There are really very few whistles produced by transmitting stations. However, nearly constant supervision is necessary to keep the stations from changing. The station operators are coöperating in this work and

Station	Standard Frequency Stations		Assigned frequency (kilocycles)	Period covered by measurements (months)	Number of times measured	Deviations from assigned frequencies noted in measurements	
	Owner	Location				Average	Greatest since Mar. 20, 1925
						Per ct.	*Per ct.*
WQL	Radio Corporation of America.	Coram Hill, Long Island, N. Y.	17.13	4	31	0.1	0.2
NSS	United States Navy	Annapolis, Md	17.50	20	156	.2	.6
WCI	Radio Corporation of America.	Barnegat, N. J	17.95	2	13	.2	.3
WGG	do	Tuckerton No. 1, N. J.	18.86	20	159	.1	.4
WSO	do	Marion, Mass	25.80	20	122	.3	.2
WVA	United States Army	Annapolis, Md	100	1	20	.1	.4
WEAF	American Telegraph & Telephone Co.	New York, N. Y	610	4	45	.0	.0
WCAP	Chesapeake & Potomac Telephone Co	Washington, D. C	640	19	87	.1	.2
WRC	Radio Corporation of America.	do	640	16	69	.1	.2
WSB	Atlanta Journal	Atlanta, Ga	700	19	78	.1	.4
WGY	General Electric Co	Schenectady, N. Y	790	22	124	.1	.2
WBZ	Westinghouse Electric & Manufacturing Co.	Springfield, Mass	900	12	35	.1	.4
KDKA	do	East Pittsburgh, Pa	970	19	158	.1	.3

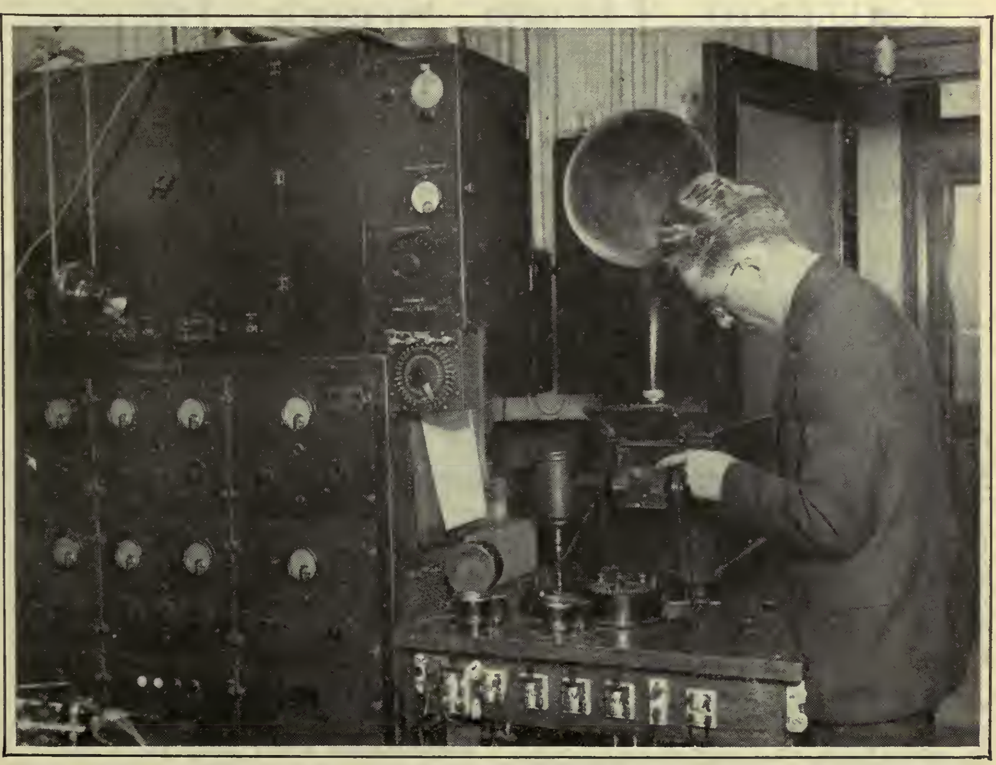
most of them are taking particular care to keep the frequency of their station where it should be.

You can assist in the elimination of beat notes produced by the interaction of the waves of two stations. Whenever you hear a whistle of constant pitch, that is, one which varies only in loudness as the controls of your receiving set are adjusted, it usually indicates that one or both of two transmitting stations are not adjusted to their assigned frequencies. If you can identify the two stations producing this whistle, notify the Supervisor of Radio in whose district the stations are located. A list of the radio districts is given at the end of this article. It is necessary that both stations which are producing the whistle be identified, for it is only necessary for one of them to be off its assigned frequency to produce a beat and without measuring instruments it is impossible to tell which one is wrong. There is also a possibility that one of the stations causing the "beating" is not a broadcasting station but an "oscillating" set of some kind whose frequency is being maintained constant. However, it is exceptional for a receiving set to be left adjusted in such a condition continuously, and whenever the frequency is changed the characteristic variable pitch whistle will be heard.

OSCILLATING RECEIVER INTERFERENCE MINIMIZED

IF THE broadcasting stations will maintain exactly their assigned frequencies it will not only eliminate the whistles caused by beats but will also help in the elimination of the other type of whistle caused by hunting for broadcasting stations while the receiving set is in an oscillating condition. When a transmitting station is located on the tuning dials, a record can be made of the dial setting. Then the next time it is desired to find out if that station is operating, all that is necessary is to set the controls at the point determined before. New stations can also be located with respect to the position of known stations.

The maintaining of the exact frequency of broadcasting stations therefore is of twofold importance: (1) the elimination of the whistles produced by the stations themselves, and (2)



"SEEING" THE RADIO WAVE

At WJZ, an oscillograph, or visual means for observing the character of the transmitted wave, is employed to check up on transmission. With this instrument the engineer may see whether his wave is within bounds, during all broadcast periods

increase in the ease of setting the dials to find stations and so eliminating some of the whistles produced by hunting for stations with a generating (oscillating) receiving set.

SUPERVISORS OF RADIO

First District —Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut—U. S. Supervisor of Radio, Customhouse, Boston, Massachusetts.

Second District —New York City and vicinity, Southeastern New York—U. S. Supervisor of Radio, Customhouse, New York, New York.

Third District —Eastern Pennsylvania, Southern New Jersey, Delaware, Maryland, Virginia, D. C.—U. S. Supervisor of Radio, Customhouse, Baltimore, Maryland.

Fourth District —North Carolina, South Carolina, Georgia, Florida,—U. S. Supervisor of Radio, Federal Building, Atlanta, Georgia.

Fifth District —Tennessee, Alabama, Louisiana, Mississippi, Arkansas, Oklahoma, Texas, New Mexico—U. S. Supervisor of Radio, Customhouse, New Orleans, Louisiana.

Sixth District —Arizona, Utah, Nevada, California—U. S. Supervisor of Radio, Customhouse, San Francisco, California.

Seventh District—Washington, Oregon, Idaho, Montana, Wyoming—U. S. Supervisor of Radio, 2301 L. C. Smith Bldg., Seattle, Washington.

Eighth District —New York (except second district), Western Pennsylvania, West Virginia, Ohio, Michigan—U. S. .Supervisor of Radio, Federal Bldg., Detroit, Michigan.

Ninth District —Indiana, Illinois, Kentucky, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, Colorado—U. S. Supervisor of Radio, Federal Bldg., Chicago, Illinois.

Cutting Down Spark Interference on the Great Lakes

Results of the Canadian-American Conference at Detroit Which Will Result in Better Receiving Conditions for Upper New York, Ohio, Michigan, Ontario, Illinois, Indiana, Wisconsin, and Minnesota

By CORLEY W. KIRBY

INTERFERENCE from spark transmitting stations, which has regularly marred broadcast reception in every city along the Great Lakes, will be eliminated as a result of the conference held in Detroit May 4th and 5th by representatives of the United States Department of Commerce and the Canadian Department of Marine and Fisheries. In addition to representatives of the two governments, the conference was attended by representatives of the Canadian and American commercial radio companies, steamship companies and others who were directly interested.

The recommendations of the conference, which will undoubtedly be accepted by the respective governments, and which were agreed to by the commercial representatives attending, follow:

All Canadian and American coast and ship stations on the Great Lakes open for general public service business must be equipped to work on a frequency of 420 kilocycles (a wavelength of 715 meters), which will be the normal frequency of the station. All Canadian and American stations must maintain a watch on this frequency.

The frequency of 342 kc. (875 meters) is authorized for the handling of general public service correspondence. The use of this wavelength by coastal stations is optional.

Communication between a coastal station and a station on shipboard or between ship stations shall be exchanged on the part of both by means of the same wavelength.

For general public service, communications between ship and shore and ship and ship when working with stations other than the nearest station must be on a wavelength of 875 meters or higher. Communication with a distant station will not be permitted if interference with the nearby station results.

All correspondence transmitted from a ship or shore station will be in regular message form and

TWO LARGE GREAT LAKES PASSENGER SHIPS

The SS. *South American*, which runs between Chicago and Buffalo, and the SS. *Tionesta* which is one of two other passenger ships running between Buffalo and Duluth. There are many similar passenger ships and many more cargo vessels whose radio traffic, carried on with spark transmitters near the broadcast band has caused interference with broadcast receivers throughout much of the Middle West. The *North American* and *South American* and a number of cargo vessels have been equipped with continuous wave transmitters which does much to do away with broadcast interference. Vessels on the Pacific and Atlantic coasts are gradually being changed to continuous wave equipment also

copies of these communications must be placed on file.

The practice of transmitting notes under the prefix svc or carrying on unofficial conversations must be discontinued.

The United States Government was represented by D. B. Carson, Commissioner of Navigation, and chairman of the conference; W. D. Terrell, Chief Supervisor of Radio; Arthur Batcheller, Supervisor of Radio at New York; E. A. Beane, Supervisor of Radio at Chicago, and S. W. Edwards, Supervisor of Radio at Detroit.

The principal Canadian delegates were C. P. Edwards, Director of Radio Service for the Department of Marine and Fisheries;

CANADIAN AND AMERICAN RADIO OFFICIALS AT THE CONFERENCE

Held at Detroit, which arrived at the agreement to move the commercial radio communication channels above the broadcast range. At the head of the table is D. B. Carson, Commissioner of Navigation, Department of Commerce. Next on his left is E. A. Beane, Radio Supervisor at Chicago, C. P. Edwards, Director of the Radio Service of the Canadian Government, Department of Marine and Fisheries; next to Mr. Edwards is W. D. Terrell, Chief Supervisor of Radio, Department of Commerce, and next, Arthur Batcheller, New York Radio Supervisor. H. M. Short, Managing Director of the Canadian Marconi Company is at the left of Mr. Carson

THE HARBOR AT DULUTH, MINNESOTA

With Superior, Wisconsin, in the background. Duluth is the Northern terminus of Great Lakes steamship lines, and many cargo and passenger ships have carried on commercial radio traffic while in or near this area which has seriously interfered with broadcast reception. Radio listeners as far West as Minneapolis have been bothered by interference from ships on Lake Superior. The new agreement which goes into effect July 15th lifts the ship-to-shore bands above broadcast channels

W. A. Rush and S. J. Ellis, Supervisors of Radio in Canada, and H. M. Short, Managing Director of the Canadian Marconi Company.

The acceptance of the recommendations of the conference means the readjustment of the equipment of every ship and shore radio station on the Great Lakes. Due to the immense amount of work required to do this, the date when all of the changes must be completed has been set for midnight July 15. There are more than 300 ship and 50 shore stations which will go on wavelengths beyond the range of the broadcast receivers as a result of the conference.

Since the advent of radio broadcasting, the interference from the old type spark transmitters used in handling lake traffic has been most annoying during the summer months when navigation on the lakes was in full swing. This interference has been recognized by every one connected with radio as one of the greatest drawbacks to summer radio reception, but the expense which would be involved in changing all of them to non-interfering transmitters was considered too great for the commercial companies to bear.

THE CANADIAN GOVERNMENT CALLED THE CONFERENCE

THIS conference, which was called on the initiative of the Canadian government, reached an inexpensive and satisfactory solution of the problem with very little difficulty. As a result of the accord arrived at, there will probably be annual conferences of a like nature to discuss problems which are of mutual concern to the two governments.

"We have recognized that the number of broadcast listeners is constantly increasing, and it was the result of a desire to bring them pleasure and enjoyment from summer radio that prompted the calling of this conference," said C. P. Edwards, Director of the Canadian Radio Service. "Our government this year is spending more than $50,000 in changing the Sarnia, Toronto, Sault Sainte Marie, and Port Arthur shore stations from spark transmitters to continuous wave sets which cannot interfere which broadcast reception. These Canadian stations were equipped with 5½ k. w. 240-cycle synchronous spark transmitters.

"An effort has been made to get all ships to cease using their radio transmitters while passing through the Detroit River and have them report to their respective companies by land lines; but this would cause expensive delays, and for the present all ships will continue to transmit necessary and important business while they are passing through the Detroit River. Finally, when all spark transmitters are outlawed by international agreement, all possibility of interference from commercial sources will be eliminated for the broadcast listener. I expect this agreement to be reached in March, 1926, at the scheduled International Conference at Washington."

KING ALFONSO OF SPAIN

Before the microphone of the new Madrid broadcasting station. It is interesting to note the Marconi type microphone, suspended in a cradle of sponge rubber

THE MARCH OF RADIO

By J. H. Morecroft

Past President, Institute of Radio Engineers

The Increasing Use of Short Waves

IF ONE read the signs of the times aright, we shall all have to acquaint ourselves with sets designed for frequencies about ten times as high as those we use to-day. The ordinary frequency range to which we are accustomed extends from 545.1 to 1363 kilocycles (550 to 220 meters) and the recent accounts of the progress of radio indicate that we must soon be tuning our sets from one thousand to ten thousand kilocycles, (300 to 30 meters), ten times our present frequency.

We have often spoken of the necessity of extending our present broadcast band in order to minimize interference among the ever increasing number of broadcasting stations. From the accounts of short wave work we continually see, it will not only be advisable; but necessary to go to these higher frequencies.

At three o'clock in the morning some British amateurs (what enthusiastic fellows they must be!), working with a portable field set, picked up American amateurs using only a few watts of very high frequency power. With a frequency of about fifteen thousand kilocycles, (20 meters), an English amateur has been able to communicate with a fellow Britisher in Australia. Our navy is carrying on extensive

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BRITISH AMATEURS ON A FIELD DAY

The radio societies of Golders Green, Hendon, Hournslow, and Inland Revenue held an outdoor meeting recently. Their short wave transmitter is shown in the photograph. Successful communication was obtained in daylight with American amateurs

tests with frequencies between five thousand and fifteen thousand kilocycles (60 to 20 meters), and is reporting unusual success with these waves and very small power. Argentina and South Africa have been able to carry reliable communications with small amounts of power at these high frequencies.

Sets designed for receiving these very short waves are very different from those to which we are accustomed. Condensers of two or three plates and small coils of from five to ten turns, depending upon their diameter, make up the tuning circuits; the antenna may be from ten to twenty feet long. There is almost as much difference in appearance between these sets and those we are using to-day as there is between our present ones and the receivers used for commercial transoceanic telegraphy.

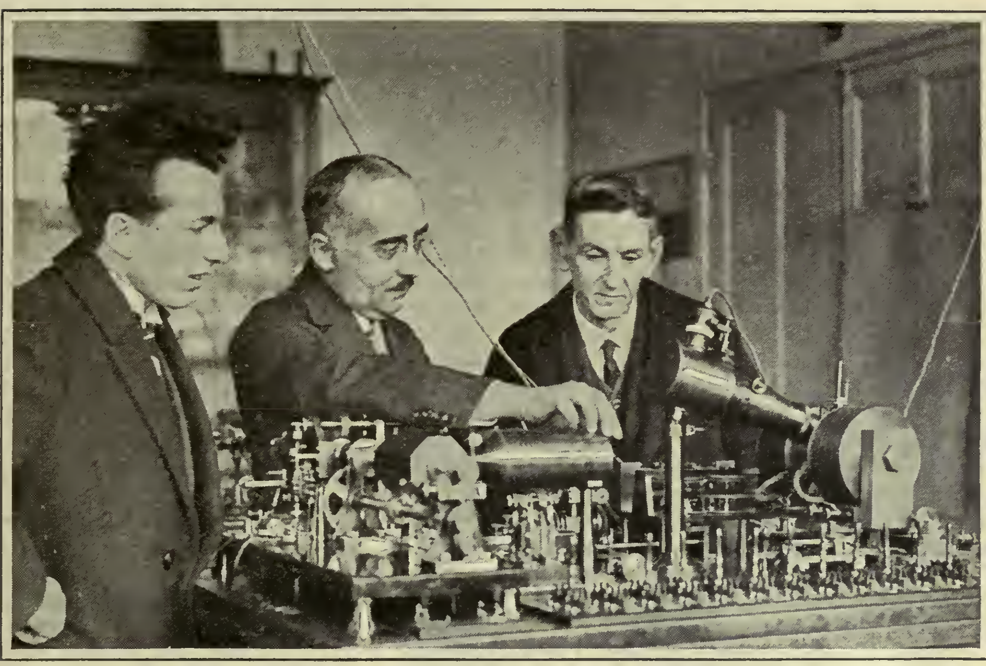
Radio Comes to the Russian

ACCORDING to the Russian Information Bureau in Washington, even the lethargic Russian peasant is being rapidly converted to an appreciation of radio. Not only is the number of private receiving sets rapidly increasing, despite the poverty of the average Russian to-day, but a more interesting development is taking place.

In the Moscow province alone, two hundred additional village reading rooms were equipped with receiving sets and loud speakers during the past season. Thus radio news becomes directly available to the peasant who could hardly afford a set of his own and also attracts him to a village center where other educating influences are at work.

The use of private receiving sets was prohibited by the Soviet Government up until last fall, when a licensing scheme went into effect. In Moscow alone it was estimated there were at least twenty thousand illegal sets in use before governmental permission for their maintenance was granted. Within two months after the licensing arrangement went into effect there were more than fifty thousand sets in use.

The State controls the radio industry in the same way that it controls all the others. Radio comes under the control of the Commissariat of Posts and Telegraphs. That bureau has forty-three transmitting stations and two hundred and eighty-two receiving stations, scattered throughout the territory of the Soviet union under its direction. The



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M. EDOUARD BÉLIN

Explaining his system of transmission of photographs by wire. It is understood that little change in the equipment is necessary for application to radio circuits. For sending telegraphic messages, the exact original is duplicated at the receiving end. The Paris Post Office is using the system

manufacture of radio machinery, including receiving sets and parts, has been concentrated in a State manufacturing syndicate which operates three factories in Leningrad, one in Moscow, and one in Nijni-Novgorod. The Russian Information Service calls the Moscow factory one of the largest and most modern of those in Europe.

The Amateur Can Try Radio Pictures

EVER in the forefront of radio development, the amateur has now been invited by Mr. C. Francis Jenkins, well known for his radio picture development, to share his experiments. Mr. Jenkins has devised apparatus for radio picture transmission which has showed itself practicable to a certain extent and now apparently feels that the amateur can help to work the apparatus up into a form which may possibly be of more service than at present.

The Government will permit amateurs to carry on these experiments, provided they stay within their prescribed frequency limits, and Mr. Jenkins is ready to furnish apparatus which will start the keen amateur off on a new radio venture. Incidentally, if he takes up the study of radio picture transmission seriously, the experiments will impart to the embryo radio engineer a good deal of modern science.

What Broadcast Wave Is Best?

MANY problems of radio, such as the amount of static or other interference present, prevalence of fading, etc., can be solved only by the statistical method. If an engineer wants to solve a technical problem he generally goes to his laboratory, sets up the proper apparatus and directly gets the necessary answer. If an insurance executive wants to know how long you or I will live, so he can offer fair insurance rates, he looks up vital statistics on perhaps one hundred thousand others about like us in age and occupation and so gets the answer for his problem by the so-called statistical method. It seems that many of radio's problems must be solved in this fashion.

WGY is now sending out its programs simultaneously on four frequencies of approximately 180.6, 790, 1750, and 7890 kiloycycles (1600, 379.5, 171.3, and 38 meters). The ordinary broadcast receiver will tune for only one of these, 790 kilocycles, but with a little work,

a short wave tuner can be built to receive the two higher ones, and the experiment is well worth trying. Schenectady is keeping a reccord of the amount of power they send out on the different antennas, and if listeners will send to the engineers a record as to how well the program was received on the different frequencies, whether static interfered more in one channel than in another, where fading was most noticeable, etc., a mass of data will be accumulated which will be useful in obtaining a statistical answer to the question as to what frequencies are best for broadcasting.

Receiving Is Good in California

THE California "booster" has still another catchy phrase with which to advertise his Heaven on Earth. "No Static" is the phrase which measurements recently made by the Bureau of Standards Transmission Laboratory permit the Californian to add to the present long list of that country's attractions.

The scientist talks about radio signals as so many "micro-volts per meter." A radio wave carries with it, or rather is, an electric field, whose intensity determines how loud the signal will be when properly received. An idea of the extremely weak electric field associated with signals from distant stations may be had from this comparison.

The ordinary dry cell develops an electromotive force of about 1.5 volts. In the air between the two terminals of a battery there is an electric field, rather weak to be sure, but still strong enough to be detected by a sensitive instrument. (The air will stand an electric field of about twenty thousand volts per inch before breaking down, permitting a spark to pass). If now we attach two metal plates to the terminals of the battery, hold them parallel to one another and about fifty inches apart, the electric field between these two plates will be about one volt per meter. As the plates are moved farther and farther apart, the electric field between them becomes correspondingly weaker, and if we were able to get the plates about one thousand miles apart, and still have them connected to the two terminals of the dry cell, the electric field would be about one micro-volt per meter. An electric field so weak is far past the comprehension, or even the imagination, of one who has not continually worked along scientific lines.

According to Dr. L. W. Austin, the man who has done more in this field than any other American scientist, the signals from Europe in the Eastern United States, are from twenty to one hundred micro-volts per meter in strength. This is a good readable signal unless static is exceptionally bad. This same experimenter, working on the California coast, finds that the received signals from Java and the Philippines are only two to five micro-volts per meter and yet these weak signals are readable. That such weak electric fields are sufficient for successful communication speaks volumes for the absence of atmospheric disturbance on our West coast. A corresponding signal strength on the East coast of our country would be completely buried in the noise produced by atmospheric disturbances.

The Radio Situation in South America

THE president of the Radio Corporation has just returned from an extensive visit to South America. "In spite of foreign competition" he says, "American products and methods remain the most acceptable to South Americans." That must be good news for his company, which is actively striving to gain the South American market. There seems to be an increasing demand both for transmitting and receiving apparatus.

The installation of more transmitting stations seems to be the immediate need in South America. In our country one station serves, on the average, six thousand square miles of territory, General Harbord says, while in South America, one station serves three hundred thousand square miles. The General might also have added that in our country most of the stations try to serve the same six thousand square miles.

Commenting on the economic situation General Harbord remarks that the bill for broadcasting is in most cases paid for by radio advertisers and the trade, which cooperate with the stations to the extent of putting aside a percentage of their revenues from the sales of receiving sets to meet the broadcasting expense. Some stations accept advertisements from local merchants and these paid advertisements are sandwiched between the musical numbers which make up the program. The novelty of radio, and scarcity of diversified programs, make the listeners tolerate advertising for the present, but there is no indication, according to General Harbord's opinion, that this method of payment will be the final solution of the problem in South America.

Frauds in Manufacturing

THOSE acquainted with the development of commercial radio during the last two decades are well aware of its rather checkered career. Many a man has thought of radio as the happy hunting ground for stock promotion.

A radio fraud not so evident as these has recently come to light, and we are glad to say that the alleged swindler is speedily to be brought to trial. One of the well known resistor manufacturers, the Daven Radio Corporation, who, by care and engineering talent have built up a reputation for accurate resistors to be used as grid leaks etc., discovered that the product sold to the public under his trademark was by no means was dependable as the factory tests showed.

District Attorney Salomon was sufficiently impressed by the evidence of illegal traffic that he proceeded against the alleged head of this swindling ring, Moe Goldman. It appeared that the resistors Goldman was putting out were most unreliable. The reliable manufacturers in the radio field are not so numerous that we can afford to have our faith in any of them shaken by such methods as Goldman was apparently using.

Who Will Protect the Radio Listener?

PAUL B. KLUGH, Executive Chairman of the National Association of Broadcasters, recently commented on the present crowded condition of the ether, due to the limited frequency band available for class B stations and the ever increasing demand for room in this field by new stations.

Apparently having in mind some certain cantankerous manager, Mr. Klugh said:

> Unless a certain broadcasting station, which is dissatisfied with its present wave allottment, recedes from the position it has taken, the matter will probably land in the courts. This would be unfortunate because under the present law, Secretary Hoover is almost defenseless and is doing his best to preserve harmony. It is a hard thing to dissuade certain citizens, conversant with those phases of the Constitution which guarantee "equality," from demanding that which they believe to be their rights. The fact that the air is crowded to the limit doesn't interest them.

It is almost certain that the next Congress will pass some legislation giving to the Secretary of Commerce more legal hold on the broadcast situation. It is no secret that he

THE NAVY GIVES INSTRUCTION

To interested natives in Hawaii. Since the lessons are distinctly personal, it is evident that greater success can be had with head phones than the more public loud speaker

© Barratt's

ARTHUR BURROWS

The first manager of the new International Broadcast Bureau at Geneva. It is Mr. Burrows's work to attempt an amicable settlement of disputed points between the Continental broadcasters. There are said to be fifty-two stations there for forty-eight possible wave bands. Mr. Burrows was assistant controller and director of programs for the British Broadcasting Company

has practically none at present. It might be a very good thing to have a court fight on record so that our congressmen who have delayed action so long might be convinced that some action is an immediate necessity.

Mr. Klugh speaks for the broadcasters. But who speaks for the listeners? When one talks about equality in this broadcast tangle, the listener must come into the argument too. The broadcast channels must be assigned and used in such a manner that the most good and enjoyment comes to the millions of listeners. With this idea in mind, it is evident at once that the granting of a license to a new station should not rest at all on so-called constitutional rights. The desires of the listeners who will be benefited or be disturbed by the new broadcast channel should rule the granting of the license.

The Radio Service Needs Money

A WASHINGTON dispatch to the New York *Herald-Tribune* says that Secretary Hoover will ask Congress next winter for an appropriation for the support of more adequate radio inspection. There are entirely too few radio inspectors now in the Department of Commerce service. Their number is small and their primary duty is to look out for marine radio. The radio inspection service was organized specifically to see that radio was installed and used at land stations and on shipboard so as to afford a maximum of protection.

When the problems of broadcasting descended on them, a tremendous increase of work has been loaded on the entirely inadequate inspection bureau. With the hundreds of broadcasting stations which have to be supervised by the few government men, and the hundreds of thousands of single-circuit regenerative receivers acting as transmitters, it is no wonder that thousands of complaints which pour into the radio bureau of the Department of Commerce receive such scant consideration. They simply cannot be handled.

The dispatch referred to above states that $125,000 is to be requested for extra radio "cops," whose function it will be to keep their eyes on the broadcast channels, eliminating interference where possible and generally acting to keep the ether traffic moving in orderly manner. One hopes the Commerce Bureau will get this needed financial aid.

Supply and Demand in Radio

CERTAIN commodities enjoy a year round demand. We need telephone service, for example, just as much in the spring as in the fall, and just as many groceries in the summer as in the winter. Not so with radio apparatus, however; there is great decrease in the public demand for radio material as the summer months approach. In spite of many published opinions to the contrary, every sensible person knows that radio is not as much in demand in summer as in winter. Furthermore the outdoor attractions in summer call us away from the easy chair and the radio entertainment and probably it is best for us that such is the case.

Radio sales must be extremely seasonable. A radio manufacturer may look for a healthy demand for his products possibly eight months in the year and he must so organize his finances and production that the four comparatively "light" months do not force him into bankruptcy. This past season has caused many a downfall because these precautions were not taken. It is no secret that the great demand for sets last fall caused many an inexperienced manufacturer to overload himself with parts and complete sets, so that when the slump came he found himself with finished apparatus for

which there was no demand, an excessive inventory of parts, and a painfully strained credit.

A manufacturer in such a situation must sell his output no matter how great the sacrifice. It may bankrupt him to move out his goods at half their listed price but if they didn't move at all he surely would be ruined. This situation caused a tremendous dumping of sets on the market this spring and dozens of different sets could be bought for less than half their original selling price. In spite of this enforced movement of sacrificed sets, many smaller firms were forced to the wall. The industry probably benefited by the withdrawal of these poorly organized concerns. The public will be hesitant about purchasing sets in the fall at say a hundred dollars when past experience leads them to believe the same set can be purchased for forty-five dollars in the spring. This condition is unhealthy and is not conducive to a real March of Radio. Why is it not logical for the business man, launching out into the radio game, to emulate the iceman in a small town? Ice, coal, and wood, are his products, and fickle indeed must be the season when one or the other of his wares is not in demand. The radio business would be most economically carried on in conjunction with some other electrical enterprise (sufficiently like radio so that the same machinery and employees could be used) which would keep the factory busy at times when atmospherics and the open air turn our desires away from radio receivers.

"Ethics" In Radio

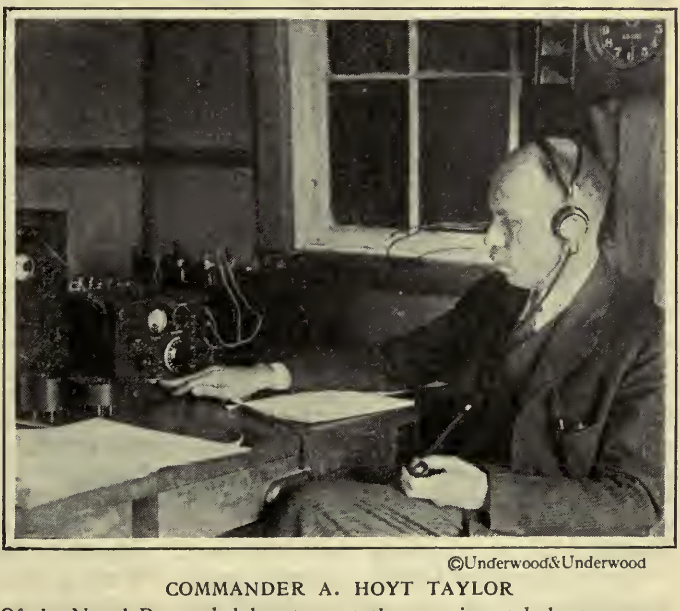
THERE are many of us who have sensed a very unsavory condition in certain commercial aspects of radio and certainly the recent proceedings between the Radio Corporation and the De Forest Company do nothing to weaken the impression that some of the commercial ethics of the radio are not of the highest type.

The first inkling the public had of the bad feeling between the two companies referred to above was in newspaper reports to the effect that the Radio Corporation had planted spies throughout the plant of the De Forest Company. Further, it was said that these spies were delivering to the Radio Corporation all of the De Forest secrets which might be useful to a competitor — manufacturing processes and costs, sources of supplies, names of customers, quantities of apparatus sold and terms allowed to jobbers. The reports seemed to show that by this system of espionage the Radio Corporation was well on its way to ferret out every bit of information which might be of value in competitive warfare.

So serious were these charges that one was inclined to disbelieve them. An emphatic denial was awaited from the Radio Corporation officials. But the denial did not come; instead it was admitted that the Radio Corporation had actually established a system of spies in the De Forest plant and that these spies did bring their information to one of the Radio Corporation's trusted employes.

In the preliminary hearing, the Radio Corporation was enjoined from further spying on De Forest but was granted permission to use, for patent infringement purposes, whatever pertinent information its spy system had already brought forth.

Actions of this kind don't impress the radio public very favorably.



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COMMANDER A. HOYT TAYLOR

Of the Naval Research laboratory at the experimental short wave receiver. Using a 21-meter wave, operators at the laboratory recently communicated with Australia, a distance of more than 10,000 miles. A power of less than one kw. was used

The Month in Radio

THE Hazeltine Corporation reports that during 1923, the public bought 95,094 Neutrodyne sets, During 1924 a total of 279,780, and during the present year 129,630 such sets had been sold up to May first. These figures show that more than 500,000 neutrodyne sets have been manufactured and sold during the brief life of the patent.

IN THE annual summary of telegraph statistics, published by the Berne International Wireless Telegraph Bureau, it is shown that radio has had an ever increasing rôle in maintaining safety of life at sea. At the end of 1913, there were 3998 ship-to-shore stations in use, at the end of 1919, 6623 such stations, and at the end of 1924 there were 16,971 stations carrying messages from land to sea and vice versa.

GENERAL HARBORD'S report that foreigners like our radio apparatus is well borne out by the figures on exports for the present year. Last year the total radio exports were only slightly over $6,000,000., but the present year makes a much better showing. Figures for corresponding months of last year and this year show the following values for radio exports.

	1924	1925
January	$ 331,849.00	$ 784,619.00
February	302,121.00	477,591.00
March	288,812.00	604,769.00
April	279,903.00	853.148.00
Total	$1,222,685.00	$2,720,127.00

These figures indicate a total export for this year of more than $8,000,000.

IN SEPTEMBER, three Navy seaplanes will hop off from San Diego for Honolulu, thus furthering the prestige of an air force which already has the Newfoundland-Azores flight to its credit. The distance to be covered is much greater than the long flight of 1919, for twenty-eight hundred miles separate San Diego and Hawaii.

Careful preparations are being carried out to insure the safety of the venturesome pilots, and radio is expected to do its part. Unlike Amundsen, who kept us all on edge for many days wondering where he was and how he was faring (he had no radio apparatus whatsoever), our flyers will carry the most modern radio outfits. The transmitters are of one hundred watts rating and should be good for transmitting at least five hundred miles.

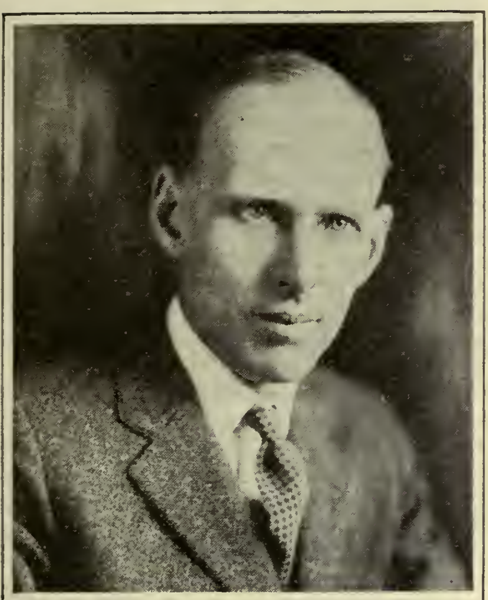
It is interesting to note that the very short waves with which broadcast engineers are experimenting nowadays have been found unsuitable for airplanes. The ignition system of the engine is a prolific source of highly damped, high frequency currents which seriously interfere with the reception of signals in the region of ten thousand kilocycles (30 meters).

THE Music Master Corporation has just concluded a contract with the Ware Radio Corporation by which, hereafter, all the Ware products are to be marketed through the Music Master Company. The output of these combined companies will in the future carry the trade name "Music Master-Ware."

THE annual talk on the budget and taxes by President Coolidge and General Lord, was broadcast over a large part of our country a short time ago. These annual talks by those officials responsible for spending the money we pay as taxes seem an excellent illustration of the value of radio in government. If county and state officials likewise were made to account for their expenditures so that the taxpayers might see where their money was going, this good work of radio would be extended in the right direction and undoubtedly state and local taxes might be diminished the same as the federal taxes have been.

AT Bound Brook, New Jersey, the Radio Corporation's engineers are erecting what we had expected to pronounce the largest broadcast station in the world, but evidently the Germans are to outdo us. By next winter they expect to have on the air a station in Bavaria which will send out one hundred kilowatts of power. Some trouble may be experienced in the control of this amount of power by the human voice, but with their well known technical ability the German engineers will undoubtedly accomplish it. A frequency of three hundred kilocycles (1000 meters) is to be used at this new Bavarian station.

Another large German station of fifty kilowatts rating is being erected at Königswusterhausen. With these two large stations it is expected that all Germans, even if equipped with crystal sets only, will be able to pick up broadcast programs. It is not at all un-



H. A. BELLOWS

Minneapolis; Director, Gold Medal Station WCCO

"Any one who would now undertake to say what can be done through a great broadcasting station would be simply inviting trouble. An agency for the distribution of ideas, for education, service, and entertainment, has been created so suddenly that its possible scope is still impossible to define.

"The only real guide to the direction of a radio broadcasting station is public service. It is impossible to give everybody everything he wants. Just as a great newspaper combines its news, market, editorial, and sports features with its entertainment and educational features, so we are trying to make the service rendered to the public by our station so full that every listener, no matter who he is or where he may be, will feel that we have something of direct and personal value to him."

likely that many American listeners, at least in the winter time, will also hear these German stations.

AN INTERESTING example of how much unwise faith we place on our impressions was illustrated by the dispatch stating that 2LO, London, had recently changed its antenna arrangement and as a result many of the listeners had reported improvements in signal strength of twenty-five per cent. and some even as much as fifty per cent. It might interest these listeners to know that even if two signals are compared on the same night, one right after the other, not one of them could tell if one signal was twenty-five per cent. louder than the other and if the signals were on successive nights, as theirs must have been, they couldn't possibly have told if one signal was one hundred per cent. louder. The ear is of little value as a measurer of sound intensity, probably because it has never been used in work of this kind. If two signals are compared on successive nights it would require a difference of several times rather than a few per cent. before the ear would give a reliable indication of change.

AFTER many tests to ascertain the utility of radio beacons on the coast of France, the Undersecretary of Merchant Marine, M. Danielou, has become convinced that his country would do well to help their navigators by putting in a quite extensive installation. A total of about thirty such radio searchlights are to be put in as soon as possible, some of them sufficiently powerful to be of use to vessels hundreds of miles at sea, some of them of low power for the guidance of ships in the larger harbors, while most of them will have a fifty-mile range.

AFEW months ago we heard a deal of talk about broadcast silent night, the idea being that one night of the week should be kept free by local broadcasters so that DX fans might have a chance to tune-in distant stations. Thus if New York stations all stopped broadcasting at 8 P. M., New Yorkers who so desired might listen to Philadelphia or Chicago, or other large cities. Similarly, the listeners in these cities could hear New York if their local stations kept off the air once every week. The idea doesn't seem to be "taking" at all. Chicago tried it, but new stations going on the air in that city do not anticipate falling in with this scheme.

It is quite evident to any one that listeners in New York City, for example, cannot hope to hear distant stations under ordinary conditions; with a dozen or more powerful local stations going, the station a thousand miles away has small chance of coming through on the average radio receiver. We can well see why New Yorkers don't take up the silent night idea but think it might be worth while for some of the other cities to do so. The best radio programs obtainable are sent out from New York, so what is the use of depriving the listeners of this entertainment that a few enthusiasts may tell their fellow workers on the morrow that they heard Cuba, or San Francisco. Silent night may be observed on Main Street, but it never will be on Broadway.

SIR JAMES A. M. ELDER

New York; Commissioner for Australia in the United States

"No element of world intercourse to-day is so pregnant with possibility or so potentially effective in the world's relationships as that modern miracle—the radio. While personal visitation and conversation must always remain preëminent in the world's activities and work, these are necessarily restricted to but a comparative few; radio reaches millions. Radio has brought America and Australia still closer together and is cementing the existing close friendship. The projection of the human voice across leagues of land and ocean opens up inestimable possibilities for the future.

"Some months ago, I had the unique privilege of speaking to Australia from Pittsburgh, a distance of ten thousand miles, an historic and epochmaking event. Radio is already in the possession of all Americans. It is a daily domestic necessity. In Australia, its use is rapidly extending; it is bringing the life of the great world into the homes and lives of sturdy pioneers in the far interior. Their isolation has disappeared, and their leisure hours are occupied to the full in these personal advantages which the radio provides. Radio is destined to be as popular in Australia as in America."

Why is the Radio Conference Postponed?

THE League of Nations has recommended that the coming international radio conference called by the United States to meet in Washington this fall be postponed until 1927. Government officials in Washington who have been interviewed were apparently inclined to believe that the League's recommendation would be followed.

It appears that, from the European point of view, postponement is advisable. A Paris radio conference is called for September of this year and the actions of this conference will of course affect the views of European delegates who attend the United States conference. There are various matters which the new agencies of Europe wish to bring up for action and it seems that the European conferees would do well to discuss their problems before bringing them to Washington. Our recent Pan-American conference is regarded as pointing the way for this preliminary European meeting.

Matters which the European contingent of the conference expect to bring up include the inviolability of messages, particularly copyrighted press matter, establishment of rules concerning multiple address messages delivered by the no-answer method, and censorship of radio telephone broadcasting. It seems that among other items which we might logically bring up for discussion is that of broadcast licenses. The idea of liberty has, it seems, gone to the limit in this field; month after month new licenses are issued and these certainly are not, in the main, for the benefit of the listening public. It certainly would do no harm to have a general open discussion on this question, and among those contributing to the discussion should be some capable representatives of the broadcast listeners.

We feel that there are too many matters of great importance now pending for this international conference to be postponed. It should be held not later than the Winter of 1925.

The Music Publishers Oppose Broadcasting

AT THEIR annual convention, the National Association of Sheet Music Dealers passed a resolution which expressed their idea of radio's help to sheet music sales. Radio may stimulate their sales for a short time, it was said, but in the long run the sales are decreased if the song is used in the radio channels. In the discussion, it was admitted that for music of a semiclassical nature the demand has increased after being broadcast by artists of ability. Some of the convention members pointed out that songs of a generation past, entirely forgotten, have been revived by using them in the radio programs.

Mr. Samuel Fox, one of the sheet music

publishers, however, favored the most stringent regulation of the broadcast performance of copyrighted music. He would have the publishers tell the broadcast program director just when and how he might use their songs.

Several dealers had expressed the idea that radio had increased their sheet music sales, but Mr. Fox requested that the minutes of the conference be changed so that this favorable comment regarding radio would be deleted.

Interesting Things Interestingly Said

E. H. ANDERSON (New York; Director of the New York Public Library): "Neither the movies, radio, or crossword puzzles have caused any decrease in the use of books, but whenever a decrease does occur in the use of books (in the New York Library) it is because of a shortage of books."

KENNETH B. WARNER (Hartford, Connecticut; Editor, *QST*, the official publication of the American Radio Relay League, writing about international amateur radio experiments on short waves): "To us the most fascinating angle to this international DX game is that it isn't a rich man's sport and it doesn't take an expert. It's wide open to everybody. The lowest-powered transmitters in the country are heard as far as the big watt-eaters, and the very simplest ham tuner pulls in the signals from the other side of the earth. We don't know to what it is leading, but it surely seems to be advancing that dream of ours of the day when large numbers of private citizens all over the world will sit down at their personally owned apparatus and converse with their friends in every clime. Amateur radio is performing a powerful service in the advancement of world-understanding."

MELVILLE E. STONE (New York; Counselor Associated Press): "I don't believe that radio can ever compete with the newspaper in supplying the public with news. There are fundamental difficulties in the collection and transmission of news by radio that could not meet the organized facilities of the coöperative associations of the newspapers for gathering and distributing news."

A CONVERSATION in the House of Commons quoted in the New York *Times* relating to unauthorized making of phonograph records from radio programs: Sir B. Chadwick, Parliamentary Secretary for the Board of Trade said: "There has been such a remarkable growth in radio that the law has not kept pace with it. There is reason to believe that the day is not far distant when an eager public may listen to the proceedings of Parliament.

One member: "God help us."

The Deputy Speaker: "I would point out that the bill refers to musical and dramatic performances."

COSMO HAMILTON: (New York; playwright and author): "Radio will profoundly affect writing in the next few years. Novelists will have to boil down their productions from the 100,000 words of the present to 5000 words, so that they may be read over the radio. In five years, reading will be superseded to a great extent. The public will listen to the author's stories over the radio and see its plays in the moving picture theaters."

COLONEL ALLEN S. PECK (Denver; District Forester in charge of government timber lands in Colorado, Wyoming, South Dakota, Nebraska, Michigan, and Minnesota): "A large number of the 200 rangers and twenty-six supervisors on duty in our six states are equipped with radio receiving sets. The fire warnings which are being broadcast over station KOA will therefore be of the greatest practical value. Radio will also be of the greatest value in reaching hundreds of coöperators and keymen in time of danger. Fire warnings will have the broadcast right-of-way at KOA."

CHAUNCEY M. DEPEW (New York; publicist; in an address opening WRNY, New York): "Many boys and girls listening to me this evening have made their own radio machines. The boys and girls of to-day have so many opportunities for their mental and spiritual advancement, which never existed before, that we older people wonder how we ever got on at all. . . . Much as we admire and wonder at these marvels, of which radio is one, which are the commonplace of our day, one may well wonder if they are necessary to greatness or great achievements. The greatest thinkers of antiquity, Plato, Socrates, and Aristotle, the guides of modern times, had none of these wonders. Washington, Lincoln, and the others accomplished their great and immortal deeds with only such opportunities as their times afforded."

THE Rev. Dr. James M. Ludlow (Pastor Emeritus, Munn Avenue Presbyterian Church, East Orange, New Jersey): "Radio is a scientific gain to humanity and a genuine pleasure to all mankind and will elevate the standards of sermons of ministers all over the country. Clergymen know that their church members would remain at home to hear a good sermon being broadcast rather than go to a church to hear the usual line which so often is given out from the pulpit on Sunday."

IN AN editorial in the New York *Times:* ". . . Yet there is no setting limits to the response of the American public to judicious stimulation. One may now go to London or Cherbourg for the price of a radio set."

H. R. KIBLER (Chicago; secretary, National Farm Radio Council): "Radio will assume a new significance to farmers and their families when it brings them, in addition to entertainment, information that can be supplied to their everyday problems. Radio must serve the farmer as a schoolhouse as well as a theatre."

What Is to Become of the Home Constructor?

Fascinating New Fields for the Enthusiastic Radio Constructor Who Wants to Go Further in Radio Than Set-Building—How to Build and Use Laboratory Apparatus Which Will Enable the Radio Student to Take a Real Share in Radio Testing and Design

By KEITH HENNEY

THE veritable army of citizens who have become radio addicts since the coming of broadcasting have found that there are two distinct pleasures in radio. The first and foremost, and certainly the most lasting joy, comes from tapping the wealth of entertainment from the "infinite reaches of the air." The second, hardly less important, is derived from the home assembly of radio parts into a complete whole. There is the pride of mechanical accomplishment in that. But as Mr. Henney brings out in this excellent article, the home constructor who has passed through the various stages of construction, finally finds himself equipped with one or more receivers which satisfy him. What is he to do then? It is of course true that radio designers are constantly making this improvement and that, and are passing the information along to readers of their articles. No enthusiast who builds radio sets, trying first this one and that until he finds what to him is the ultimate, is wasting his time; we think that he could scarcely have spent his time in better fashion. But it is our purpose in the series of articles, of which this is the first, to carry these constructors on farther, and to show them experiments which will lead them in valuable and definite directions.—THE EDITOR

THE number of radio enthusiasts in this country who have learned the great amount they know about radio from building sets must be considerable. In addition to the amateurs, those tireless non-professional investigators of anything and everything radio, there is a new body of American citizens who have amassed a great deal of radio knowledge. They have built this receiver and that and they have found out by genuine practical experience many of the great electrical facts about radio—and found them out in a reasonably painless manner.

Let us take the case of the individual whom for want of a better name we shall call the "home constructor." He has found that some of the sets he has built do what was claimed for them, while others fall short. He is not sure whether the trouble lay in his own part of the work, or in the fundamental design. It is quite probable that in his variously apportioned radio reading, our constructor has acquired a pretty good working knowledge of radio theory. But after he has built his quota of receivers, what is left for him? Should he go on building more receivers? If he is an incurable constructor, he probably does. Somewhere in his array of sets he has found a number that satisfy him. His satisfactory set gives him distance, selectivity and, best of all, quality. What then?

The editors of RADIO BROADCAST feel that there is more in radio than this type of experimenter has found. The constructor has built his receiving sets, and that is a necessary stage in his progress. He has had the real fun of making an intricate electrical unit that works; he has had a hand in harnessing those mysterious electrical forces with which so much is done and about which so little is generally known.

The home constructor is really a person with considerable mechanical and electrical talent and ingenuity, but in the last analysis he really assembles units which someone else has designed, someone better equipped technically than he.

He knows that experiments and measurements are constantly going on in well-equipped radio laboratories. New and more efficient coils must be made, the phenomena of audio frequency amplifiers and their associated apparatus is being investigated—much is yet to be learned about radio generally.

The value of the radio work of the Bureau of Standards is well known to our constructor and the bulletins describing this work may be had for the cost of printing them. Papers are read before the Institute of Radio En-

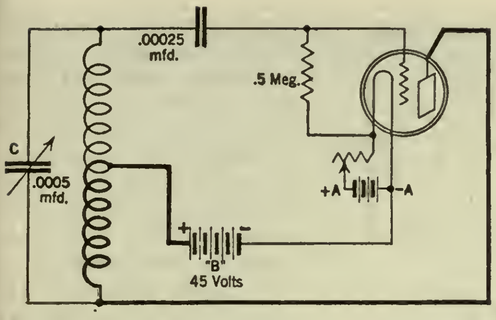


FIG. 1

The radio frequency circuit is schematically represented in this Figure. There is nothing tricky about it and the coils and condensers may be of any standard make provided their dimensions are such that they cover the range of wavelengths desired

gineers which circulate among a limited number. Probably an equal number have training to comprehend their contents.

NEW FIELDS FOR THE HOME CONSTRUCTOR

THERE is a big gap between the scientific papers and text books and the final synthesis of radio apparatus resulting from the technical discoveries which antedated them. These papers and books are either too technical, or at the other extreme, popular articles in many radio magazines are too simple. Many times the articles which attempt to popularize radio principles are incorrect or hazy, or both. Often they successfully leave the impression that the writer himself was not certain about what he wrote.

There is, unfortunately, no middle ground between the work of Government, university, and commercial laboratories and the home workshop of the constructor. It is to supply such a middle ground, that the staff of the Laboratory has been working for some months, and in future issues of RADIO BROADCAST they hope to present the result of their work. They hope to describe the building and use of simple and not too expensive apparatus which the constructor can assemble at home. With the aid of this equipment, the home constructor will find an entirely new outlet for his energies. He will no longer be forced to make new receivers, when he is on building bent, but he can turn his attention to the deeper and more lasting and equally interesting field of radio phenomena.

On the conviction that there were many of the radio fraternity who desire to know more about radio, RADIO BROADCAST was encouraged to publish in June, 1925, an article on the training required for a real radio engineer, and the promise was made that future issues of this magazine would contain experiments that the home worker could perform, experiments that may prove to be much more interesting than the construction of apparatus that someone else has designed. The response to the article on radio training has made it evident that there were many of the home constructors who were suffering somewhat from ennui from the continuous round of one receiver after another, and gave the Editors the courage to go ahead with their endeavor to entice readers of RADIO BROADCAST into the fascinating field of radio experiment.

CONSTRUCTION ARTICLES OF PRACTICAL VALUE

THESE experiments will be tied up practically to radio equipment. The methods of design will be explained. And with this explanation, will be copious references to pamphlets and text books bearing on the subject under discussion. Where mathematics is involved, aid will be given in the use of the formulas, and it is hoped that it will be possible for the interested experimenter pleasantly to learn more about the use of simple radio mathematics. There are any number of people who are not content to be told that a thing is so, they want to know why it is so. If they can discover the whys themselves, and go further after that discovery, they have an absorbing future indeed before them. And who does not feel a peculiar psychological satisfaction at accomplishing some one definite object of value?

This series of articles will come close at times to the field of general physical and electrical science. The facts that are learned about radio, will often apply to similar phenomena in the realm of sound and light, and

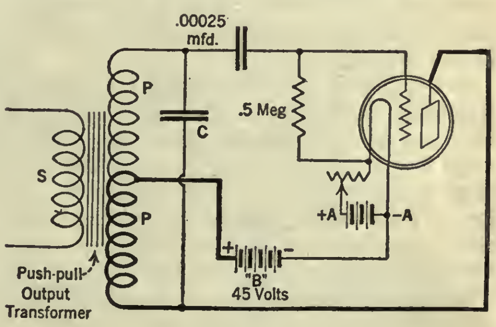


FIG. 2

The audio frequency part of the oscillator is, like the radio part, a simple Hartley circuit and a push-pull output transformer with a mid-tap may be tuned by a fixed condenser so that the tone emitted will be approximately 1000 cycles

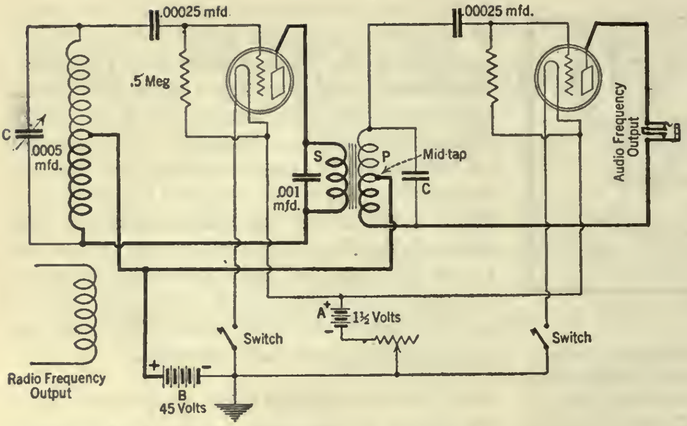


FIG. 3

This schematic diagrams represents the completed modulated oscillator with all of the accessory apparatus. Switches make it possible to operate either tube independently of the other, and in the audio-frequency oscillator is a jack so that the tone may be taken out for any of the uses described in the article

sometimes will have an important bearing on our appreciation of some of the fine arts.

It is tremendously difficult for the isolated experimenter to know all that is going on in this feverishly active field of radio. The experimenter is often at a loss to know what to read and what to do. It is distinctly possible to translate the highly interesting activities of the radio engineer into apparatus and into terms that the reasonably well-equipped experimenter can use and understand. It is just this task that the staff of RADIO BROADCAST Laboratory hopes to accomplish.

THE USEFUL MODULATED OSCILLATOR

THE first instrument that will be described has been called a "modulated oscillator," a name that perhaps sounds formidable. It is really one of the most useful, and, withal one of the most simple pieces of laboratory apparatus.

Briefly, it is a combination of a radio-frequency oscillator—a miniature transmitter—and an audio-frequency oscillator. The radio frequency part of the unit is so arranged that it will cover all frequencies from the lowest broadcasting frequency to the highest used by the transmitting amateur—from 6000 to 500 kilocycles (50 to 600 meters). The audio oscillator can be tuned to some definite tone, say 1000 cycles, and may be used to "modulate" the high frequency energy, or in the several ways mentioned below.

Either of the units comprising this apparatus may be used alone or both together, and if placed in a box including batteries, it is a self-contained miniature broadcasting station. The laboratory instrument was designed with this object in view. The entire gear was placed in a box ($10\frac{1}{2}$ x 7 x 6 inches), although it must be admitted that a larger cabinet would have made the assembly much simpler!

The radio frequency part of the circuit is shown in Fig. 1 which is a simple Hartley oscillator circuit. The condenser may be any good low loss instrument, preferably of the straight line frequency or straight line wavelength type. That used in the oscillator illustrated was the Lacault condenser with a straight line wavelength curve. The coils may be of any variety, although those of the General Radio Company are very satisfactory as regards low loss and the simplicity with which the various wave bands may be covered.

DETAILS OF THE CIRCUIT

THE audio frequency part of the circuit is shown in Fig. 2 and is composed of the output coil of a push-pull amplifier. Instead of the primary leads going to the plates of two tubes, the two ends of the winding are connected to the grid and plate of one tube. The other winding is placed in the plate circuit of the radio oscillator, thereby introducing the audible tone into that circuit.

Fig. 3 is a schematic diagram of the combined unit utilizing common A and B batteries. In the Laboratory model illustrated in Fig. 4, two WD-12 tubes were used and two dry cells were placed within the cabinet. Two switches are included so that either tube may be operated independently of the other, and a closed circuit jack is placed in the audio oscillator so that the tone may be taken out for any of the purposes suggested below.

Although the grid condenser and leak values are designated on the diagrams, these values are not at all critical and may be varied within rather wide limits before the tubes refuse to function. The size of the condenser across the radio frequency coil determines, together with the inductance of the coil, the frequency to be generated. The General Radio coils are so designed that with a .0005 mfd. condenser, the 60-turn coil will cover the range

FIG. 4
This photograph shows clearly the panel layout of the modulated oscillator and it gives an idea of how the set of coils may be used to cover the entire band of wavelengths from 50 to 600 meters

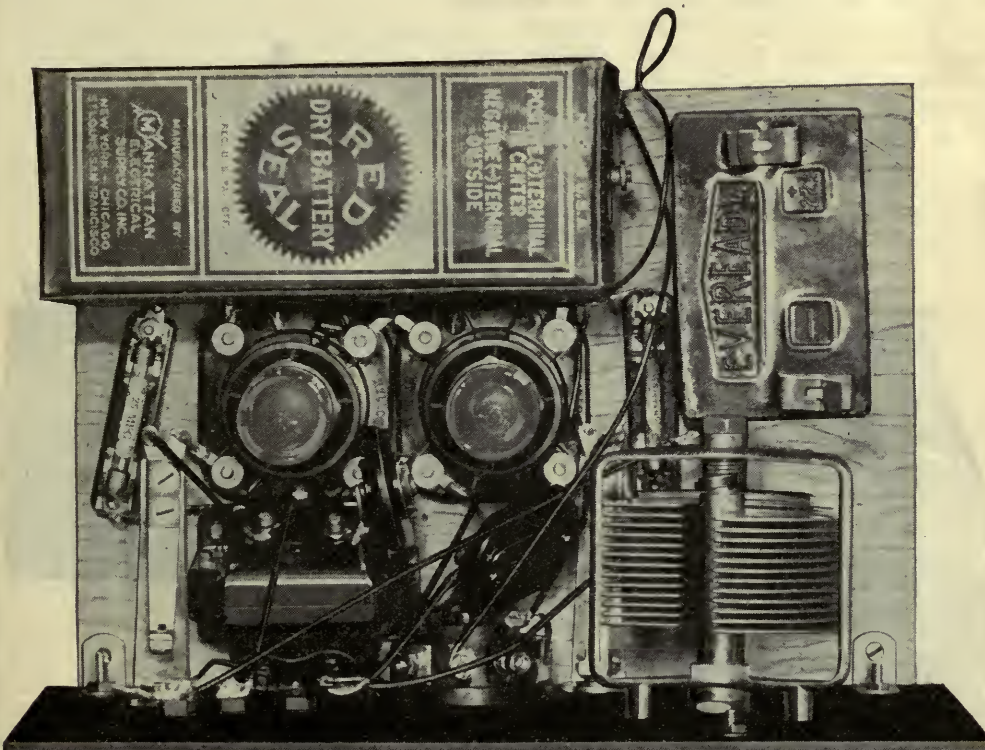


FIG. 5
The disposition of the various parts of the receiver may be seen from this photograph which looks down upon the completed oscillator. It must be admitted that less difficulty will be had in constructing the unit if more space is provided for the various parts

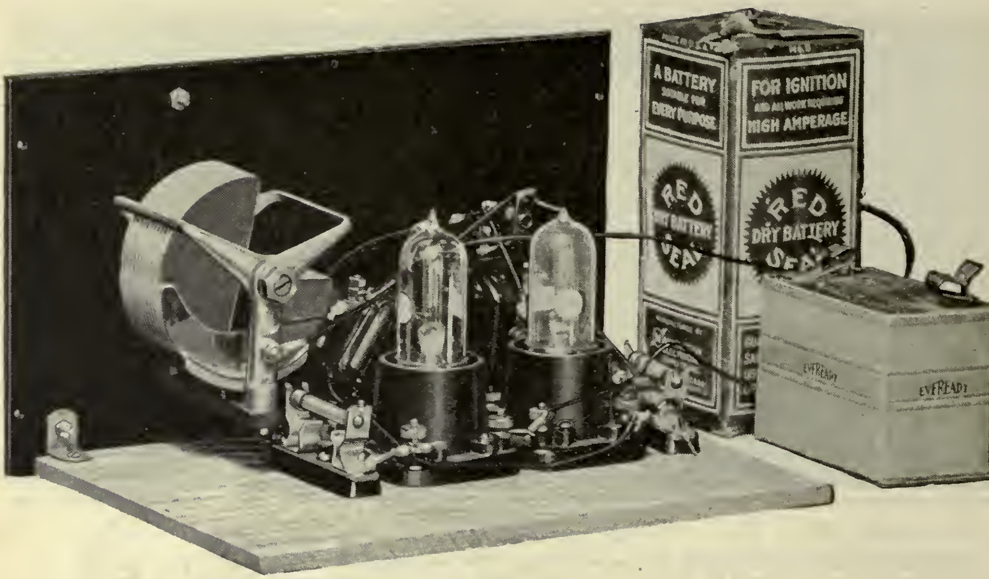


FIG. 6

A rear view of the oscillator gives a good idea of the small size of the one used in RADIO BROADCAST Laboratory. Both A and B batteries are contained in the cabinet so that it is a veritable portable broadcasting station

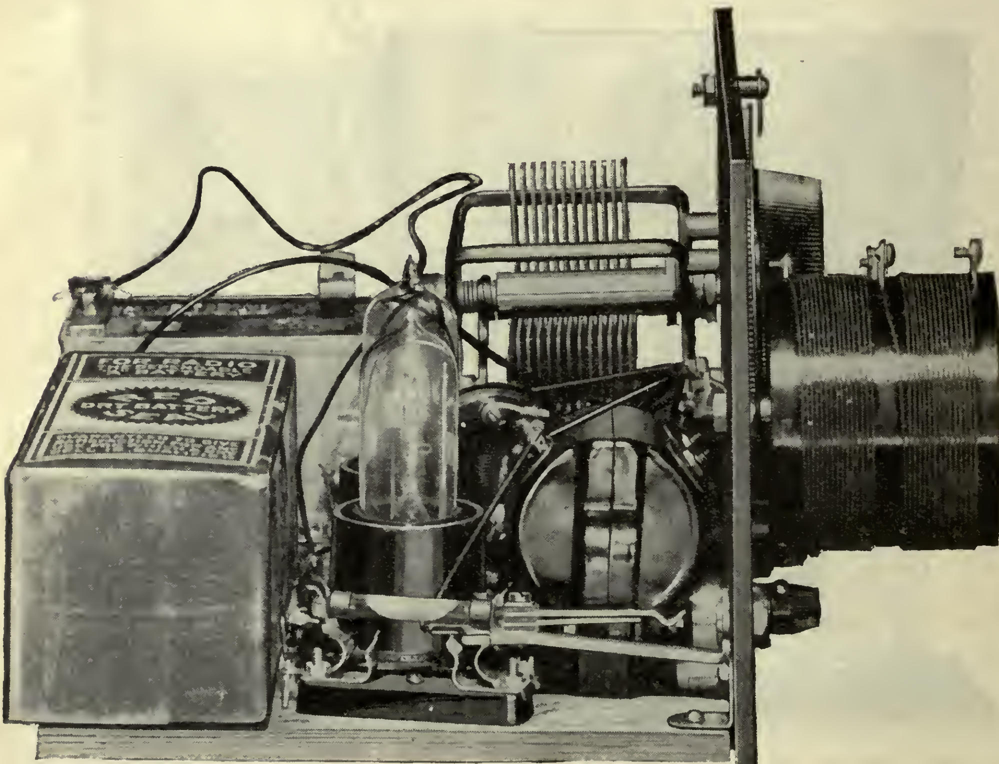


FIG. 7

An end view of the oscillator showing how the coil is placed with respect to the other equipment. This coil happens to be the one which will cover the 50 to 150 meter wavelengths

1500 to 500 kilocycles (200 to 600 meters) the 30 turn coil 3000 to 1000 kilocycles (100 to 300 meters) and the 15-turn coil, 6000 to 2000 kilocycles (50 to 150 meters).

BUILDING THE OSCILLATOR IS EASY

THE actual construction of the oscillator is not complicated. No one who has built a radio receiver should experience the slightest difficulty with this instrument. The photographs in this article show something of the layout used in the Laboratory, although more room is to be desired. The radio frequency leads between coil and condenser, and grid and plate of the associated tube should be short. Any tubes may be used; WD-12's were chosen in this case because it was possible to make the apparatus portable and self contained.

It would be well to build the low frequency part of the circuit first since only a pair of telephone receivers is necessary to ascertain whether the tube is oscillating or not. The coil used in the Laboratory's set-up was the All-American push-pull output coil, and tuned to about 1000 cycles with a condenser of .003 mfd. across the secondary. Placing the telephones across the secondary winding, or in series with the plate of the tubes will enable the constructor to tell at once what tone is being generated, and changing the tuning condenser will naturally change this tone. At about 1000 cycles, the receivers will work most efficiently, which can be told by the greater volume of sound emitted when the set-up approaches this frequency.

The actual frequency of the audio oscillator is not important, since all condenser and air-core coil measurements do not vary over the usual range of audio frequencies. The object of choosing approximately 1000 cycles is twofold. First of all, the ear is most sensitive to frequencies in this neighborhood, and secondly, telephone receivers give the greatest response at about the same frequency.

After the audio end of the oscillator is functioning properly, the radio frequency circuit may be wired. It is only necessary to bring the oscillator near a receiving set to tell whether the combined units are operating properly.

HOW TO CALIBRATE THE OSCILLATOR

THE simplest method of calibrating the oscillator is to use it in connection with a receiver whose dials are already calibrated from the frequencies of known broadcasting stations. For instance, KYW or WEAF may be tuned-in at the lower end of the broadcasting frequency band and then the modulated oscillator dial turned until the 1000-cycle note is heard in the receiver. At this point, the oscillator is sending out a signal on the frequency of the broadcasting station. If the radio-frequency condenser is a straight line wavelength affair, only two points are needed to make a wavelength curve of the oscillator, but it is safer to calibrate it by tuning-in several broadcasting stations. If the condenser is a straight line frequency instrument, a frequency curve may be made with two points. If the capacity of the condenser follows a straight line law, several points will be needed and neither the condenser degree-wavelength or frequency curve will be a straight line.

In future articles of this series will be described a new method for measuring the resistance of coils an extremely simple and accurate method that has not before been described in this country. A simple alternating current bridge developed in RADIO BROADCAST Laboratory will be described which will enable the home constructor to measure the inductance of coils, the capacity of condensers, and the resistance of various radio instruments. Other instruments and experiments will follow from time to time and whatever theory is necessary will be explained as fully as possible.

The uses to which the modulated oscillator may be put are listed below and specific directions for the use with special apparatus will follow in later articles.

USES OF THE MODULATED OSCILLATOR

1. AUDIO OSCILLATOR
   - A. Source of tone for testing open circuits.
   - B. Source of tone for measuring capacity, inductance, and resistance on an alternating current bridge.
   - C. Measuring audio frequency instruments, such as transformers, loud speakers, etc.
2. RADIO OSCILLATOR.
   - A. Source of radio frequency energy.
   - B. Separate heterodyne for super-heterodyne reception with any existing receiver.
   - C. For measuring losses in radio frequency circuits.
   - D. For measuring high frequency resistance of coils.
   - E. Heterodyne wavemeter.
3. MODULATED OSCILLATOR.
   - A. Source of modulated radio frequency energy —a miniature broadcasting station.
   - B. Calibrate receiving sets.
   - C. To measure frequency of incoming signals.

as the broadcaster sees it

by **Carl Dreher**

Drawings by Franklyn F. Stratford

How Broadcast Stations Function—From the Inside

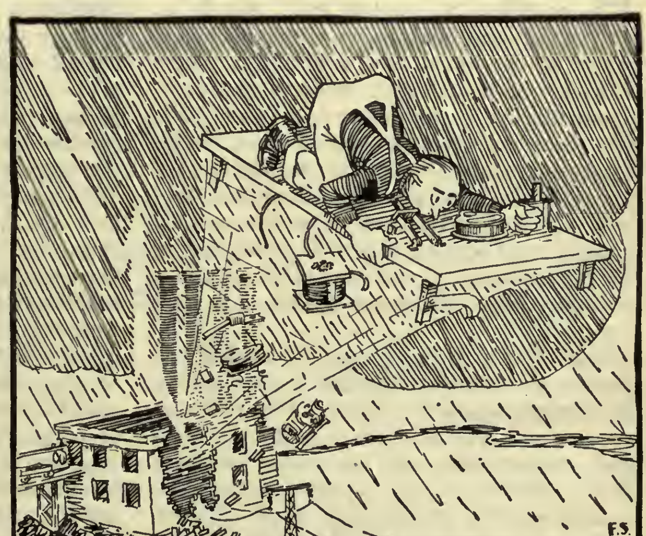
ONE of the delicate points of broadcasting station organization lies in the relation between the operators and announcers, or, in a broader sense, between the program and operating staffs. It is absent only where the diverse functions of operation and announcing are united in one genius, who cajoles the artists, pours out his soul in expositions and introductions, and at the same time keeps a fearful eye on the antenna ammeter. Before these miracle-workers of the ten-watt class we can only bow in reverence, while wishing them, in the not inappropriate airplane pilots' phrase: "Soft landings, and the best of luck!" But in all the larger stations the announcing is done by one squad of men, and the operating by another, and as a rule the two groups differ widely in background, experience, training, outlook, objects, and traditions. Yet, if the program is to run smoothly, the announcers and program people on the one hand, the operators on the other, must work together at all times; the least failure in coördination may mean a break on the air. The necessary degree of coöperation can generally be secured only when each group, (1) knows its own business thoroughly, and (2) minds it, while (3) knowing enough of the problems of the other department to grease the machinery where required. In practice, this is not always as simple as it sounds in these general terms.

The trouble with the studio people is that some of them expect miracles from the technicians. Or perhaps it would be more accurate to say that they act as if they expected miracles, while verbally disclaiming any such intention. They rarely have any engineering background, and from this it follows that they usually have a defective perception of technical requirements. They do not realize the sharp limitations of electrical equipment, and the fact that any technical enterprise is certain to fail unless the characteristics of the machinery are taken into account at every step. In engineering there are any number of ways of getting into trouble, and only a few ways—frequently only one—of doing the job right. This conclusion is beaten or burned into the hide of a technical man in his impressionable years. Any man who has suddenly found his face six inches above a 200-ampere arc when his screwdriver fell across the one-hundred-and-ten, or who has seen lightning come into an inadequately protected power plant and knock the switchboard into the next county, or viewed the remains of a $75 thermo-couple meter after the leads got twisted, conceives a wholesome respect for inanimate nature. He realizes, not merely in words, but deep down in his liver, that one does not coerce nature; one can only take advantage of what she wants to do. This understanding does not make him an engineer, but it prepares him to be one. He realizes that he must play the game according to the rules of things as they are, if he wants to play

at all. His ingenuity, resourcefulness, and general wonder-working must all be erected on that foundation. Let him forget it, and immediately he comes to grief. Huxley said: "Nature's discipline is not even a word and a blow, and the blow first, but the blow without the word. It is left to you to find out why your ears are boxed." This is true just as much in the practical applications of science as in the biological situations to which Huxley had reference. Nature encompasses the carbon granules and the stretched steel diaphragm of a microphone just as much as the digestive processes of a lion in the African jungle; everything that happens anywhere, in the woods or in a broadcasting studio, is natural. The only difference between the technician and the layman is that the technician knows better in his special field what he can't get away with. He knows also that if one opening is left the thing will go wrong, just as when there is one hole in a kettle the soup will leak out, even if the rest is sound. Hence, in broadcasting, when, to the studio group, the men in charge of transmission seem most meticulous, dilatory, and over-cautious, the only trouble with them may be that they know their business.

There is no specific reason why announcers and operators, the principal representatives, in point of numbers, of the program and technical groups, should not get on well together. They are in the same boat. Both are in the show business, in which it is impossible to confine blunders and lapses to an inner circle. The operator lives in constant anxiety that something will happen to interfere with transmission. The announcer, likewise, is always handling dynamite. He must always be ready to reconcile diverse elements, to fill in awkward gaps, and to be interesting without offending anyone in his highly variegated audience. He certainly has no sinecure. As a rule, operators and announcers live together amicably enough. When any ill feeling arises between them, it is generally found to arise through the presence of inconsiderate and conceited individuals in one group or the other. An operator may be intolerant and arbitrary. When there is time, he should always explain why he wants something done rather than take refuge behind the cloak of technical necessity, which covers a multitude of botched jobs. The mysteries of his craft are often susceptible of simple explanation to persons of average intelligence. It is not hard to explain to an announcer why he should keep his head turned toward the microphone, and he is more apt to keep it that way if he knows definitely what happens when he turns it to one side.

The announcer, on his part, just because he is a much photographed and advertised young man, should not get the idea that he is the whole works. The technical men behind the scenes are just as important as he is. It was the work of men of their class, after all, that made radio broadcasting, and got the announcers jobs in which they get more publicity per ounce of effort expended, than in any other vocation they could possibly enter. It is greatly to the credit of announcers as a class that they rarely let adulation turn their heads. Now and then the thing happens, manifesting itself in various annoying ways. I recollect one announcer, now happily departed from the pathways of the ether, who had the habit of using forms like, "*I* will now switch you over to the concert microphone. . . ." Actually the operators did the switching. It would have been better to say "we." A small matter? Yes, an exceedingly small matter. But, in this world of clashing egos, it happens to be one of those small matters which play an appreciable part in human



he conceives a respect for nature

relations, with power to influence enterprises for good or bad, according to the effect on the individuals who conduct them.

Divided responsibility has its disadvantages, but the larger broadcasting stations will probably continue to be run by two more or less independent departments, for the reason that it is rarely possible to get the required qualifications united in one individual, and because the advantages of specialization outweigh its disadvantages, on the whole and in the long run. When you listen to a broadcasting station whose program runs off smoothly, keeping up to schedule, without gaps on the air, snappy change-overs between the field and the studio, and the general impression of a systematized, properly thought-out organization, you may be sure that the technical and the studio staffs are working together, with each squad taking care of its assignment and making it as easy as possible for the others to cover theirs. When, on the contrary, you listen to false starts, wire talk going out on the air, orchestras starting while the announcer is still talking, and periods filled with nothing but the carrier hiss, the chances are that the studio and operating divisions are pulling in opposite directions. That may not be the only trouble, but it is probably one of them.

Microphone Placing in Studios

BEGINNING with this issue, it is our intention to publish each month at least one article on some technical aspect of the broadcaster's business. These articles will be on such subjects as microphone placing in studio and field work, effective broadcast station organization, maintenance problems, and various devices of practical aid in securing first-class transmission. In such a relatively new field as this, unanimity of opinion is neither to be desired nor expected, and the views of other operators of broadcasting stations will always be welcome.

One of the vital factors influencing the quality of a station's output is the placing of microphones in the studio. It is of about the same order of importance as the transmission characteristics of the audio amplifier and modulating system, which determine the treatment of the various frequencies of speech and music. If either the frequency characteristic or the microphone placing of the station should be very far off, good transmission is out of the question. By "good transmission" we mean reasonably accurate reproduction in receiving sets of the performance in the studio.

The walls of studios are generally padded with felt, or covered with curtain material of the type known as Monk's Cloth, or otherwise deadened to reduce reverberation. The reason for this is that any echo or reverberation in the studio is exaggerated or added to by the reverberation in the room in which the performance is ultimately heard through the loud speaker. The proper "reverberation time"—the time required for a sound to die down to practical inaudibility—for good musical taste, is somewhat over one second. A good studio will in general have a reverberation time well below this value. The reverberation period of the room in which the receiver is placed will then make up the difference.

The most commonly used microphone is the double-button car bontype, because of its simplicity and low impedance. The latter characteristic permits the use of long leads, whose capacity, while much too large to be placed in parallel with a condenser transmitter, is negligible, when paralleled with an impedance of some 200 ohms, like that of a carbon microphone. Fig. 1 shows, schematically, how a double-button microphone is built and connected to the amplifier system of a broadcasting station. The microphone consists of a diaphragm, D, formerly made of steel, which in later models was changed to duralumin, an alloy of aluminum, in order to improve the sensitivity and the ratio of signal output to hiss. (Inasmuch as the operation of the device requires passing a direct current through the carbon, some hiss is always present, and this may become objectionable if the sounds being picked up are very faint.) This diaphragm, about two-thousandths of an inch thick, is stretched between clamping rings, and one side (the back) is about the same distance from a flat metal surface. The combination of mechanical tension and air damping gives the necessary characteristics of very high natural frequency and damping so that the device responds uniformly to sound frequencies between about 30 and 6500, or higher, depending to some extent on the freshness of the carbon. This quality of uniform response is of course essential for good quality. If a microphone has a natural period of 1000 cycles, say, it will respond violently to notes of this pitch, giving them undue prominence; some low grade transmitters actually show this fault. Again, the low or

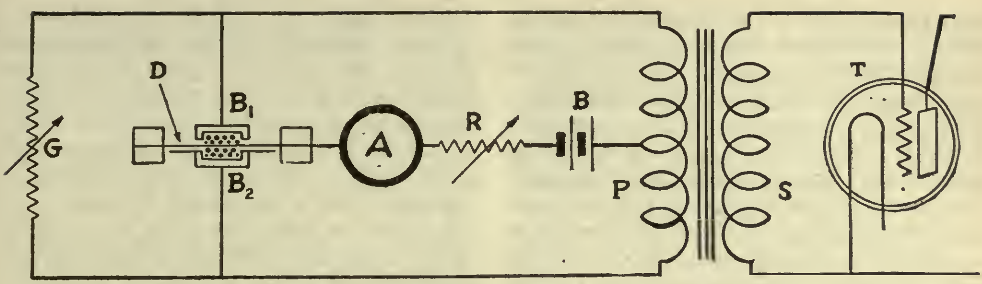


Fig. 1

high frequencies may be lost, resulting in "tinny" or "drummy" (muffled) output, respectively. It should be noted that the flat characteristic necessary for high quality reproduction is obtained only at the expense of sensitivity. The broadcasting microphone is about one one-thousandth as sensitive as the common telephone microphone, but the latter does not get much over 2000 cycles, and has an 800-cycle resonance peak. That won't do for broadcasting in the 1925 style.

The stretched diaphragm, shown at D in Fig. 1, is free to vibrate between two cups or buttons, B_1 and B_2, filled with polished globular or egg-shaped carbon granules of a peculiarly rare and aristocratic variety, the output of which is largely produced by the concern which sends you your telephone bill

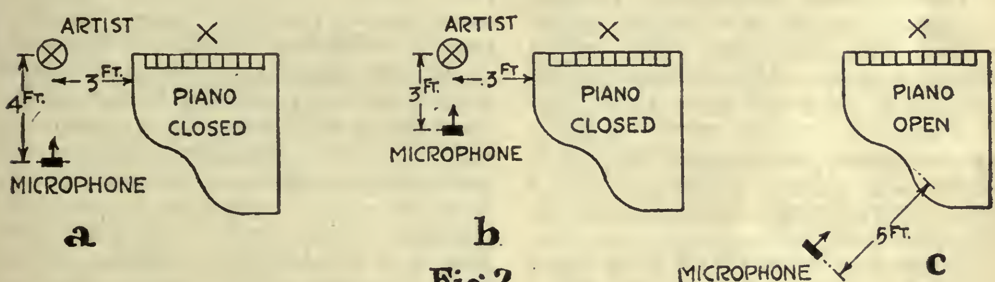


Fig. 2

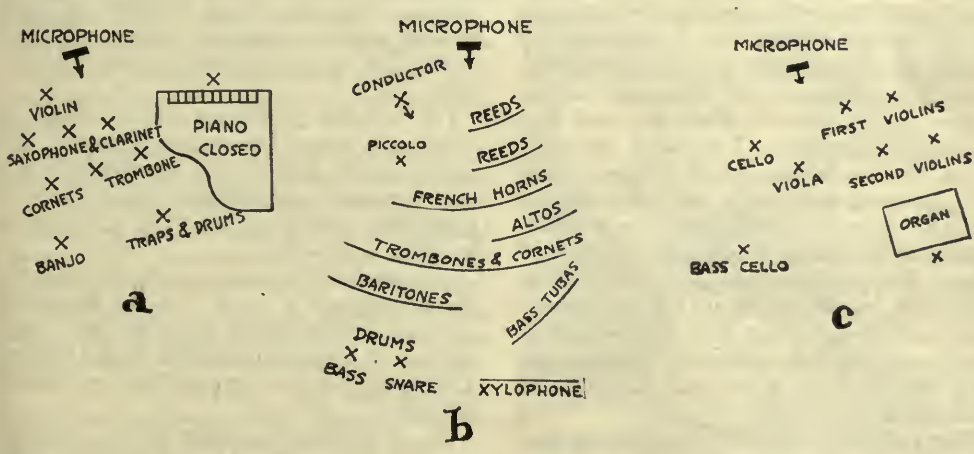


Fig. 3

each month. All is not carbon for broadcasting microphones which is black, just as all which glitters is not gold. The two buttons are connected to the primary or low impedance winding of a transformer, 1T, the secondary of which feeds a tube, and so on up to the modulators. The vibration of the diaphragm, when sound waves impinge on the open side, varies the resistance of the two carbon paths according to the push-pull principle; at the same time direct current is fed to the buttons from a battery B, with its positive terminal connected to a midpoint tap on the transformer primary, while the negative pole goes to the diaphragm through a variable resistance R and milliammeter A. The direct current is adjusted to a value of 15–20 milliamperes per button, or about 40 mA. in all. Better still, a milliammeter may be connected in each leg rather than in the common lead; then any serious difference in resistance may be detected immediately. The buttons should not differ by more than 50 per cent.; a greater divergence indicates aging carbon or some other irregularity. It will be seen that with d. c. passing through the carbon, any variation in resistance supplies an alternating current to the input transformer. This current varies in accordance with the frequency and amplitude of the sound waves which reach the diaphragm. In other words, the device is a microphone, changing sound energy to proportionate electric currents. There is also a "gain" control, G, which varies the input to the first tube.

The carbon microphone is subject to a form of distortion called "blasting," and that is one of the principal difficulties to be avoided in placing them. It is caused by excessive sound energy striking the diaphragm, and causing it to swing through such an amplitude that the carbon leaves the diaphragm momentarily, an effect which manifests itself both visually and audibly. The visual indication is on the microphone milliammeter, whose reading may drop from 40 mA. to perhaps 35 while the soprano holds a fortissimo note and takes a step forward impetuously at the same time. The audible indication is a harsh, throttling noise accompanying the music. Still another indication may be observed on the face of the control operator, who may also give expression to a blanket indictment of sopranos at such times.

The carbon in the microphone has a good deal to do with blasting. If the carbon is getting old, as indicated by rising resistance, it will blast more readily than when fresh. And, of course, it must be the right sort of carbon. However, the best microphones will blast if the sound hits them hard enough. Some voices blast more readily than others, and some instruments more than others. A cornet or trombone, for example, blasts quite readily. The violin is less liable to this difficulty, but by no means immune. The saxophone is quite free from it. It would seem that preponderance of certain high frequencies, with a steep wave-form, is conducive to blasting. Soft instruments and voices do not blast. Moderate volume is also a protection, and that is why, for broadcasting purposes, very powerful voices are not at all desirable as a general thing.

In placing microphones, one tries to avoid blasting, in the first place, and to get the correct ratio of accompaniment to voice, or of one instrument to another, as a second and equally important consideration. In this process, something depends on the performers. For example, if one encounters a baritone who persists in singing with operatic volume in a small studio, he will probably cause microphone blasting. You try to reduce the blasting by moving the "mike" away from him, thereby cutting down the energy of the sound reaching the diaphragm. The result is that you run into a lot of reflection from the walls, the energy of which begins to be comparable with the sound reaching the transmitter directly from the performer, causing more or less distortion. At the same time, you lose the pianissimo portions, for it is a fact that people who try to broadcast with excessive volume usually sing very softly in the intervals between outbursts. The only solution is to arrange with the studio manager to avoid booking soloists of extreme volume range, and to blacklist them when they get by the audition.

Fig. 2 shows (a) a good general set-up for vocal solos with piano accompaniment; and (b) for violin solos. The arrangement will vary somewhat with different studios, but it is a good first approximation. Fig. 2c is a set-up for piano solo work.

It is always bad practice to let a singer use the accompanist's notes. If the singer requires notes he should have his own music sheets. It is hardly possible to keep a balance if the soloist hovers around the keyboard of the piano.

Fig. 3 illustrates set-ups for (a) jazz orchestra; (b) brass band; and (c) string ensemble. In the case of the jazz orchestra, the violin is about three feet from the microphone,

and the farthest instruments some 14 feet. The violinist, if he is also the leader, may be angled off somewhat, so that he can direct the orchestra without being lost to the microphone. In the case of the brass band, the distance of the instruments varies from about four to thirty feet; if the studio is small, it may be necessary to obviate blasting by reversing the microphone, placing it back to the orchestra and with the bridge facing a dead surface. The string ensemble is shown with a parlor organ.

The height of the microphone is a factor which remains to be discussed. With vocal solists and violinists, it should normally be shoulder or head high. On piano solos, five feet remains about right, and this need not be changed for small ensembles. A brass band is sometimes better with microphone elevations of about seven feet. However, there are some curious nodes and anti-nodes set up in various studios which require experimentation with microphone elvations, as well as horizontal placing. The data given is only a first approximation in any case.

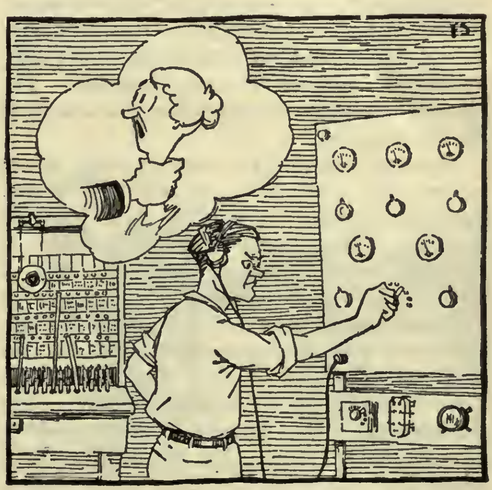
Radio Power and Noise Level

IN A recent talk before the Connecticut section of the A. I. E. E., Prof. W. J. Williams of Rensselaer Polytechnic Institute delivered himself of the opinion that power levels of broadcasting stations should remain just where they are. He is against any increase in power. The objection, to be sure, is a somewhat academic one, in view of the fact that almost everyone who can afford the money is getting a 5 kw. set to replace his 0.5 kw. outfit. Not everyone, alas, can undertake this expenditure. Among all the sounds heard in broadcasting studios, the jingling of the cash register is the least frequent.

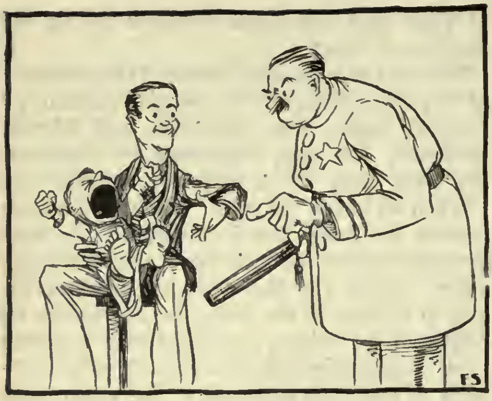
A large station costs a pile of money, and all that one gets for the disbursement, besides the ability to address the populace, is the privilege of spending a lot more cash to keep the thing going. But it is not out of pity for the groaning broadcasters that Professor Williams rises in meeting. Were it so, we should wire him our congratulations and let it go at that. He speaks, ostensibly, for the listeners. We, also, are awash with altruism. Our heart goes out to the knob-turners of the land, as does the heart of the learned engineer from R. P. I., but our reasoning is at variance with his. So much so, that we must have at him, even if the magazine is barred from the newsstands of Troy, and our name is hissed by all the listeners of WHAZ.

We shall be surprised, indeed, if the members of this WHAZ audience do not send us loads of poisoned cigars, live tarantulas, and infernal machines, for now, according to Professor Williams, they are a perfectly satisfied lot. "When we know," he says, "that this 500-watt station has been heard consistently in cool weather—about forty weeks a year for three years—across the continent in one direction and in Europe in the other, we can hardly be criticized for taking the stand that a power level of approximately this value is sufficiently high to meet the demands of the radio audience." What is *the* radio audience, and what are its demands? Possibly those members who are distance hunters pure and simple, who are satisfied to pick out the mystic letters W-H-A-Z while being batted in the ear by crashes of static, violet ray machines, electric bells, door-openers, and other miscellaneous natural and artificial noise makers—possibly this portion of the clientele is satisfied. In their interest, it might be a good thing to drop WHAZ's power to 50 watts or so. The station would be ten times as hard to hear, and the more rabid DX addicts would be proportionately happier. At the same time, Rensselaer's power bills would be somewhat reduced.

But what about the people who, while perhaps not disdaining to take a little DX flyer once in a while, want to get good music and decently intelligible speech out of their radio sets? They are getting it—from the locals,



a blanket indictment of sopranos



he expects it to be noisy

and, at greater distances, from those relatively few and enterprising stations which are in a position to pile on the kilowatts when they are needed. And what about the people whose nearest "locals" are several hundred miles away, and who want program service, not a guessing contest? Does anyone imagine that they are up in arms about so-and-so tripling the number of amperes in his antenna? Not at all, they think it is a very fine thing that they are able to get their market reports and jazz without samples of bedlam. They are in favor of an adequate signal for the farmers and ranchers, and they feel that they are entitled to it just as much as the city-dwellers. If you don't believe it, go out into the country and talk to them. Professor Williams, when he went to Hartford to deliver his paper, might have stopped off at the Berkshire village of Litchfield, 30 miles East, and inquired whether the Litchfielders get their program service from WHAZ, 73 miles to the Northwest, or WGY, 83 miles in the same direction. The answers would have given him a few foot-notes for his discourse.

Having expressed his undying trust in 500 watts, the Professor proceeds to discuss radio noise, which in part, he feels, shows a "healthy development condition," inasmuch as radio broadcasting is "the latest child of the physical sciences, and like every other child we should expect it to be noisy." This metaphor must be very comforting to discriminating listeners who want to hear the "Adagio Lamentoso" of the "Pathétique" with a quiet background. The amount of noise must be limited, we are told. By all means. Some good work is being done by public utility companies and other agencies in eliminating leaky insulators, radiating smoke precipitators, and the like; at the same time a vigorous publicity campaign against squealing receivers has greatly reduced one source of disturbance. But when we get through, considerable noise will still remain for our "supers", with their amplification of 10,000-fold, to pick up. The only way to eliminate that would be to move to Samuel Butler's *Erehwon*, where no machinery was to be permitted, thereby eliminating radio noise, radio sets, and radio problems at a single stroke. This fact Professor Williams recognizes; he admits that it is "both theoretically and practically impossible to reduce the noise level to the vanishing point, as the cost to the public of such refinements would make the price of these utilities prohibitive." If this is true of artificial disturbances, is it not even more pertinent when it comes to the natural disturbance of static? As has been pointed out in a previous article in this department, no static reducing devices applicable to broadcast reception are available. The situation, as regards both natural and artificial static, may therefore be summed up as follows (calling A the signal strength and B the static): A should be greater than B. B is too large, and cannot be economically reduced to an inconsequential level. The obvious course is to increase A. To this measure Professor Williams objects, on the ground that it will increase interference. "It is necessary to establish a reasonably low power level limit," he maintains, "as the extreme sensitivity of the receiving set cannot be used without disagreeable interference."

Let us go to the bottom of this. Why are receiving sets made so sensitive? Because people want to hear distant stations, and because those stations provide only a very weak field at distant points, a lot of amplification is required to bring up the energy to audible level. If transmitter powers were increased, there would be no necessity for using the full sensitiveness of the set at any reasonable distances. Hence station interference would not be increased, except in the case of relatively primitive receivers located close to powerful stations. Nor is there any reason why sensitive receivers, equipped with a suitable volume control, should not be capable of distortionless reception from near-by powerful stations. At the same time, the ability of the signal to ride over disturbances would be increased. As we have pointed out before in discussions on this topic, radio transmission is really the sum of two kinds of amplification, carried out at the transmitter and receiver, respectively. The first is inherently

a selective and purposeful sort of amplification which brings up the desired signal only. The second is a generalized variety of amplification which brings up signal and noise indiscriminately. The latter has been pushed to a length which is not altogether healthy, and the next rational step is a boost in the centralized amplification of transmitters. A somewhat analogous situation is found in the electrification of railroads. The primary reason for electrification is that coal can be converted into power more economically at great centralized plants, and then transmitted to the individual electric locomotives, instead of burning it at relatively low efficiency in a large number of steam locomotives. In radio the problem is not merely efficiency in the sense of ratio of output to input, but a high ratio of signal output to undesired forms of energy, i. e., noise. In both fields, however, there is a trend toward centralization and higher power as the most effective means of gaining their respective objectives.

Quantitatively, in terms of amplification, just what does increase in power of broadcast transmitters amount to? Most people have a greatly exaggerated idea of what so-called "super-power" really means. They imagine receiving tubes within a hundred miles going blue, loud speakers dancing about on the table, ceilings tumbling down, and citizens frying eggs on electric ovens attached to their antennas. No such wonders, unfortunately, will come to pass. If we assume 50 kw. as the antenna power of a super-station, it will, under the same conditions, deliver a signal louder by one stage of transformer-coupled plus one stage of resistance-coupled audio amplification, than the signal of a 500-watt installation. The signal strength being proportional to the power, the 50 kw. transmitter will, at the same distance and with all other factors held constant, give a signal strength 100 times that of a 0.5 kw. set. A single stage of audio amplification, assuming a 5:1 ratio for the transformer and an amplification constant of 5. in the tube, which is about right for a UV-199 on 90 volts plate, is good for a current amplification of 25. Follow this with one stage of resistance—or impedance-coupled amplification, and the over-all magnification is already 125, a figure greater than the multiplying factor of the 50 kw. station over its 0.5 kw. rival. If two stages of transformer amplification, with ratios of 5:1 and 3:1 respectively, should be considered, the over-all amplification is 375, a figure much in excess of 100. What a "super" transmitter of this order amounts to, therefore, is the presentation of a stage and a half of audio amplification to anyone who wants to listen to it. But amplification of the right kind, be it noted—*amplification of the signal only.* In other words, if you want to know what super-power to the extent of 50 kw. would sound like, tune-in a distant 500-watt station, and imagine its loudness increased by one and a half stages of audio amplification, without any increase in whatever interference accompanies the 500-watt signal. Or, better, assume the signal of the 500-watt station to remain constant; in that case the disturbances, for a 50 kw. outfit, will drop to one one-hundredth of the present level, or one and one half audio stages "down."

From the standpoint of the radio audience, would it not be better to have such stations, even at the expense of further loss in prestige by some of the midge broadcasters, instead of a crazy-quilt of 500-odd stations, many of which are worthless in quality of transmission and program, and serve no purpose except to caterwaul and heterodyne each other. If Mr. Williams wants to reduce station interference, he should advocate a reduction in the number of poor transmitters by enforcing decent standards of service, instead of opposing the sound engineering adjustments of organizations with the resources and determination to maintain the progress of the art. And, if he will ponder a little on the difference between the "I-think-I-heard-your-station-last-night" range and the effective service range of a station, he will perhaps reconsider an argument which is reminiscent of the early days of automobiling, when it was decreed that a flagman had to walk ahead of each automobile to prevent it from scaring horses.

the cash register seldom tinkles

The Memoirs of a Radio Engineer. IV

THE experiments of our small and youthful group of radio experimenters continued, during the summer of 1909, with the antenna lead-in swung to a small house in the backyard. This place was used for storage, and two buggy horses were also kept there, for the Bronx section of New York City was still semi-rural, and automobiles, while already common, had not yet driven out equine motive power to the present extent. This backyard was quite spacious, and not confined to the back; it also extended along the sides of the house, and contained four pear trees, two grapevines and summer-houses, and an unused well, covered with a great stone, harking back to the days when the borough had not attained the luxury of a municipal water supply. We had a miniature baseball diamond, about 20 feet square, in the yard, where we played ball during the day, and at night we foregathered, immediately after dinner, in the combined stable and storage house, to listen for wireless signals. Our set was the same: the four-wire flat top antenna, the detector of two needles with a length of pencil lead lying across them, the dry cell, and the 75-ohm watchcase telephone receiver. It was a simple set, if nothing else can be said for it. It could not squeal and disturb the neighbors, it had no knobs to turn, no tubes to burn out. We sat around it on the floor, taking turns in listening, but no sound was heard except the occasional stamp of a horse's hoof on the other side of the partition. We had a lantern, which we lit after dark, although, the set being one of zero adjustments, an expert could manage it just as well in the dark. But, light or dark, it brought in no signals. The only thing that had been changed was the ground. When the antenna came into the house the ground had been a water pipe; now it consisted of a length of gas pipe, driven into the ground between the planks of the floor. It did not get into the earth more than 18 inches, and electrically it was probably not a ground at all. We had some suspicion that it was the source of our difficulties, and we poured a few bucketsful of water on it, but without avail. Probably it would have had to go down eight or ten feet, in that dry soil, before we could have got any signals out of it. We didn't have that much pipe. Besides, we now got into trouble in another way.

In a house a few hundred feet distant, a telephone went out of order. The trouble man came around and fixed it. A few days later it again developed a fault. It was repaired once more. In some way the subscriber got it into his head that the near-by "wireless" was interfering with the telephone service. He communicated this theory to the father of one of the boys in our crew, and in vain we pointed out that we had no transmitting set, and that it was impossible that our antenna could influence a wire line in any way. People are always suspicious of anything they do not understand. The whole neighborhood believed that some nefarious principle emanated from our outfit. It was not long before the owner of the barn on which one of our antenna supports rested requested that we hang our wires somewhere else. Anyway, we were not getting any signals. We could not hear the amateur up on Prospect Avenue, nor the Waldorf Astoria Hotel, on the roof of which a grand antenna had been erected. Public opinion was against us, and there was no friendly buzzing in the telephones to encourage us. It was September, school was starting again, and we were in a low frame of mind. We took the antenna down altogether, one afternoon, and the career of our first radio set was over.

There were better sets than ours, however. From the May, 1909, issue of the primordial radio magazine, *Modern Electrics*, the following description of one of them, owned by Mr. Ernest Carter of Abilene, Texas, is lifted:

> Enclosed please find a picture of my wireless station. I am 15 years old and have been experimenting with wireless six months. On the right are the sending instruments. I use a one-inch induction coil, and run my coil from the 110 volts alternating current here. I use a water rheostat in connection with same; this gives very good results. You can see rheostat just back of coil.
>
> I use two 3-quart Leyden jars for sending condenser, one on each side of spark gap. On this side of coil is my sending helix, which I made from 10 feet of No. 8 brass wire. The spark gap is on top of coil. I use an ordinary strap key for sending. With these instruments I can easily get a station 5 miles from here. For receiving I use 3 complete outfits, one is a 75-ohm relay with a coherer and decoherer, which signals me.
>
> Another is a 1,000-ohm receiver which I made from a 75-ohm one, and an "auto" coherer with a rheostat regulator. The last one is a 1000-ohm receiver in connection with an electrolytic detector, tuning coil, condenser, and a potentiometer made of German silver wire. With the above instruments at night I can hear the Galveston and Dallas stations. I use the "auto" coherer to communicate with my friends that have stations here.

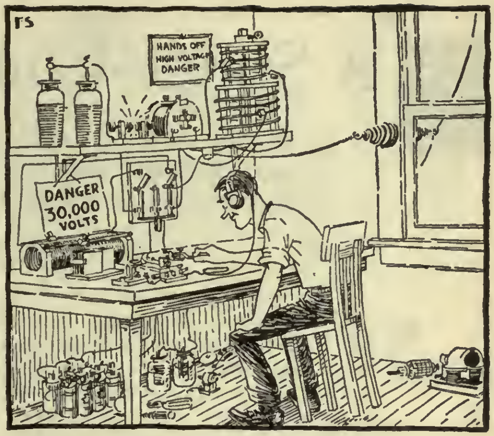
Just to the right above the coil is my d. p. d. t. switch, used to connect the sending and receiving with ground and aerial. My aërial is suspended from two 50-foot poles and is composed of 2 No. 14 B. S. copper wires 50 feet long and 2 feet apart.

Modern Electrics is a fine magazine, especially for wireless experimenters, and is a great help to me.

This was indeed a grand set, and it won the first prize of $3 in the "Wireless Telegraph Contest." The 15-year-old experimenter already had the temerity to feed his spark coil from the 110-volt circuit, curbing it with a water rheostat; yet it was good for 5 miles. He was the possessor of "3 complete outfits," including the 1000-ohm receiver made out of a 75-ohm one—a characteristic touch! Finally, this Sybarite gloried in the possession of such astounding instruments as an electrolytic detector, a tuning coil, a condenser, and a potentiometer made of German silver wire. All I can say is that he would not have been safe in our neighborhood. Unfortunately the picture printed with the description does not lend itself to reproduction.

The runner-up in this "Wireless Telegraph Contest" was Mr. Bowden Washington, who has since become a prominent radio engineer, and a Fellow of the Institute. No doubt in other issues, numerous names appear which were obscure at that time, whose owners later played great rôles on the radio stage.

The contrast between the problems of the radio experimenter of sixteen years ago and those of to-day is rather striking. Broadly speaking, the problems of to-day are those of congestion, while those of 1909 were questions arising from the primitive state of the art and the limitations of both quantity and quality of personnel, equipment, and information. To-day our problem is not to hear stations, but, often, to shut them out, in order that we may listen to one desired signal. At the time of which I am writing, an experimenter often listened for hours without hearing a signal. There were not many stations, and with the rudimentary receiving equipment available only a few near-by transmitters could be heard at best. Picking up a signal was an event. "I heard a station last night," the proud operator would inform everyone he met the next morning. To-day there are not wavelengths enough to go around. Stations are crowded 10 kilocycles apart, and most of them have to divide time, or encounter interference, or feel some of the other effects of congestion. In 1909, compared to this, radio was an anarchist's paradise. If you wanted to put up a station and send, you asked no one's leave. You picked any wavelength you pleased, which was probably whatever wavelength your antenna happened to have, in its natural and innocent state. The Government took no notice of you. It did not assign you to 704.2 kilocycles, for no one knew what a kilocycle was. If anyone interfered with you, you could abuse him in Morse, and the police power would not interfere unless you followed it up with a personal assault. This procedure, incidentally, was quite *comme il faût*; many a pair of commercial operators met on West Street, New York, after a voyage, to have it out with their fists over an incident of "jamming" which had marred the serenity of the ether, as late as 1914. Good old days, bad old days, as you please; only one thing is sure:—we shall never see anything like them again.



you could abuse him in morse

A Single-Control Receiver

Recent Developments in a Multi-Stage, Neutralized, Tuned Radio Frequency Receiver—Some Experiences and Data on Neutralizing Methods

By C. L. FARRAND

THIS paper is the second by Mr. Farrand giving the constants and data on his tuned radio frequency receiver known as the super-pliodyne. The first paper was printed in the July RADIO BROADCAST *and dealt with the experiments and developmental work on the circuit. This paper describes further work on the neutralization methods used in the receiver. It is one of the Radio Club of America papers which appear exclusively in this magazine.*—THE EDITOR

IN A paper read before the Radio Club of America on February 20, 1924, published in RADIO BROADCAST for July, 1925, a method of neutralizing feed-back in vacuum tubes, due to capacity coupling of the electrodes, was described. The purpose of the present paper is to describe a new method of neutralization which leads to greater selectivity and which may be combined with the former method to secure a desired selectivity and sensitivity.

The former method gave what in the present day would be considered minimum selectivity. The greatly increased number of broadcasting stations has, in turn, increased the demand for greater selectivity in sets. It was in attempting to satisfy this demand that the new method was derived. The selectivity of a multi-stage radio-frequency amplifier increases rapidly with the number of stages. The circuit design for each stage may be such that with a single stage, the selectivity may be entirely unsatisfactory; yet, with the chosen number of stages in circuit, the desired selectivity would be obtained. It is therefore necessary, dependant upon the number of stages to be used, to regulate the selectivity of each circuit to the desired value. In this, it is assumed that all the radio frequency circuits of the several stages are similar.

The circuit of each stage of, for example, a two-stage amplifier, must be extremely sharp. This same circuit used in a five-or-six-stage amplifier would have such selectivity that it would be practically impossible to tune the stations in. Amplifiers have been constructed with a single control so selective that stations could only be tuned-in with extreme difficulty. Stations of substantial volume in that case were passed over without being noticed.

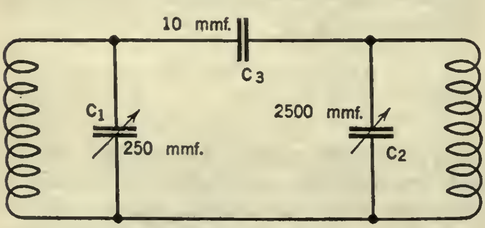


FIG. 1

TUNING THIS SINGLE-CONTROL RECEIVER

IN THE manipulation of a single-control receiver of this type, the rotation of the control dial from 200 meters to 550 meters can be accomplished by a simple half revolution. The incoming signals of different wavelengths, as they are passed through rapidly, give rise only to a dull thud or click, sounding much the same as when the grid of an oscillating receiver is touched, stopping the oscillations. At times, twenty or thirty such station clicks may be heard with one turn of the control dial. If the control is stopped at one of the clicking points, the modulation will come through.

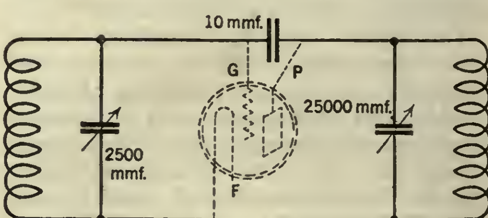


FIG. 2

It is, furthermore, necessary that the amplifier circuits be tuned in unison. It is obvious that the sharper the tuning of each circuit, the greater will be the difficulty experienced in maintaining tuning of each circuit. It is, however, practical in commercial production, to secure selectivity at least equal to that obtained by some super-heterodyne receivers, considering only one tuning position. The super-heterodyne, at the best, tunes at two points and, if not properly designed, at four and more tuning positions. The Super-Pliodyne receiver, using this system, tunes only at one point. The

necessity of matching individual circuits of the receiver has produced a uniformity of circuits from receiver to receiver within very accurate limits and, consequently, the entire receiver becomes practically a precision wavemeter; variation in calibration of the receiver varying about two meters.

COUPLING IN VACUUM TUBE CIRCUITS

IT IS obvious that the coupling of vacuum tubes and their associated circuits caused by the grid-to-plate capacity is dependent upon the proportion of the associated capacities due to the internal capacity of the tube. That is, if the circuit capacity is equal to the electrode, the capacity of tube coupling will be very great. If, however, the circuit capacity is very large in comparison to the electrode capacity, the coupling will be small.

The actual coupling, with a given coupling capacity and given input and output capacities, is independent of wavelength. In other words, the coupling is dependent upon the ratio of electrode capacity to input and output tuning capacity only, and not strictly speaking dependent upon wavelength. The coupling, K, is given by the equation

$$K = \frac{C_3}{\sqrt{(C_1+C_3)\,(C_2+C_3)}}$$

A circuit as shown in Fig. 1 would regenerate and oscillate vigorously when connected as vacuum tube input and output circuit. However, a circuit as

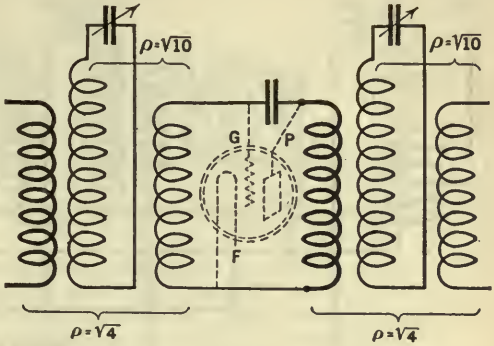
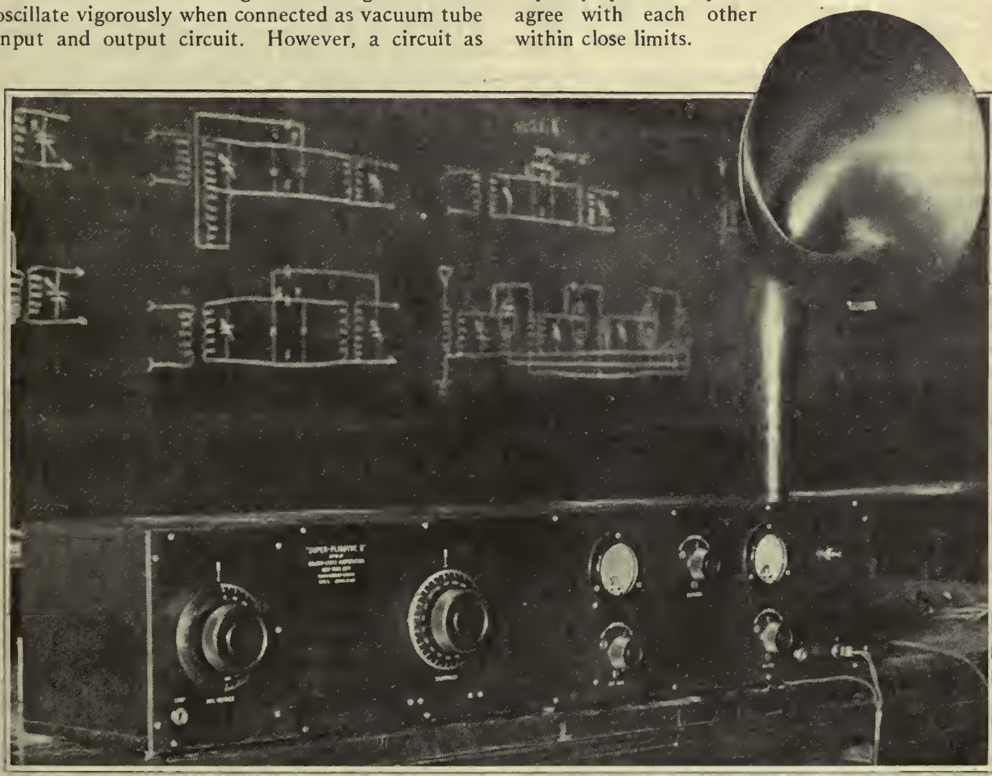


FIG. 3

shown in Fig. 2, with the input and output tuning capacities increased tenfold, would have a coupling coefficient of one tenth that of Fig. 1 and would be very stable.

In other words, a successful radio-frequency amplifier could be built which would have no tendency to regenerate, using a capacity of the order of .0025 mfd. tuning the input circuit, and .025 mfd. tuning the output circuit. It is, however, impracticable to build variable condensers of such capacity, particularly if it is desired to have them agree with each other within close limits.



A COMPLETED RECEIVER

Six stages of radio frequency amplification are used in this model. The set can be used with a very short antenna and in his demonstration before the Radio Club, Mr. Farrand used a 12-foot wire

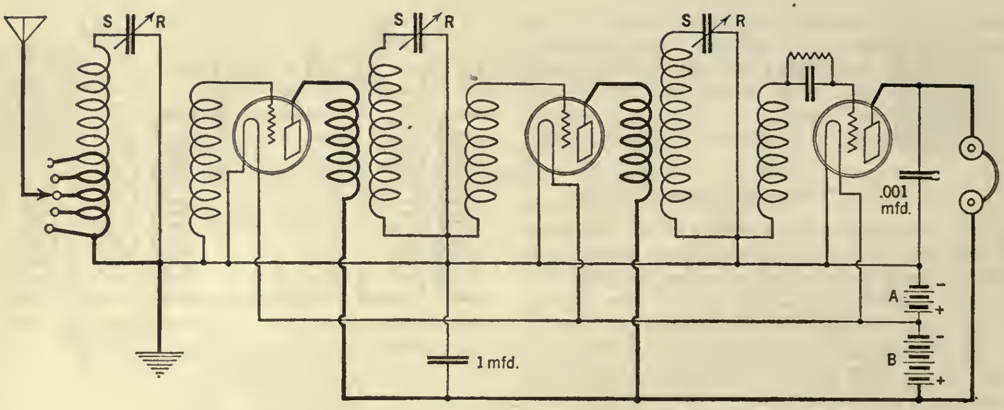


FIG. 4

The same result can be secured by resorting to a transformer. It is well known that a capacity connected to one winding of a transformer will be effective across the terminals of the other winding inversely as the square of the ratio of turns of the transformer, assuming the transformer has unity coupling. In practice it is difficult to approach unity coupling and the relations are slightly different, requiring, in general, an increase in turns of the untuned windings.

TUNING CIRCUITS OF THIS SET

THE present method involves connecting the tuning condenser of a chosen size which, from practical consideration, should be approximately 250 mmfd. across the terminals of a tuning winding. (See Fig. 3) Closely coupled to each other and to this winding are an input winding and an output winding. The input winding and output winding are chosen with a step-up ratio to satisfy the output and input impedances of a tube. This ratio should be between 3 and $4\frac{1}{2}$ to 1, depending upon the tubes used. In the Figure, a ratio of $\sqrt{10}$ or 3.16 is used. The ratio of turns of these two windings to the tuning winding is chosen so as to increase the effective tuning capacity of the grid circuit and, consequently, will increase the effective tuning capacity of the plate circuit. In practice, the ratio to be chosen depends upon the number of stages to be used, as it is necessary to use a more broadly tuned circuit with a greater number of stages.

For a two-stage amplifier, the ratio of tuning winding to grid winding should be about 2. For a five-stage amplifier, this ratio should be about three.

In view of the fact that the effective tuning capacity of the grid circuit has been increased, the resulting load of the input impedances of the tube upon the tuning circuit has been decreased. In this way, tuning is materially sharpened. In case the selectivity is too great, the compromise design may be made with the method described in the previous paper. The transformer may be designed so that only a portion of the interstage coupling is neutralized by increasing of effective capacity, and the remainder of the capacity is neutralized by connection of resistance between the plate and grid electrode. (A condenser may be connected in series with a resistance to prevent a flow of direct current from the common plate battery.) In this way, the over-all selectivity of the amplifier may be regulated within very wide limits.

The effect of the input capacity of the vacuum tube upon the tuning is less. This is because the transformer makes the effective tuning capacity larger in proportion to the input capacity. This is advantageous as it is possible to increase the wavelength range within the scale of a condenser of given size. In practice, a range of 200 to 555 meters can be secured with a capacity of 250 mmfd.

The same effect may be produced by auto transformer construction but is less desirable on account of circuit difficulties.

It is desirable to destroy the natural period of the grid winding of the transformer by winding it with resistance wire. This has no effect upon the operation of the transformer.

It is also desirable to locate the transformer (input and output) winding at the low potential end of the tuning winding. This tends to prevent losses and permit a larger wavelength range.

Fig. 4 shows a two-stage radio-frequency amplifier circuit. The plate winding consists of 15 turns, wound left hand; the grid winding 47 turns of resistance wire wound right hand; the tuning winding 80 turns, wound right hand. The plate and grid windings are tightly coupled together, of equal length and about one third the length of the tuning winding, and are placed at the filament end. The plate winding is placed between the grid and tuning winding; the end of the plate winding opposite the filament ends of grid and tuning winding is connected to plate. The end of the plate winding opposite the grid end of grid winding, toward the stator end of the tuning winding, is connected to positive plate battery.

For the Radio Beginner

How to Build the R. B. One-Tube Knockout Receiver

THERE are so many beginners in radio who want to know how to build a good but inexpensive receiver that a series of articles, of which this is the third, have been prepared by Mr. Zeh Bouck, especially for the inexperienced builder. Most of the material for the first two receivers, described in the July and August numbers of this magazine, can be built from workable parts obtained at the five-and-ten cent stores. The simple crystal receiver, described in the July magazine can be built for about $1.82, while the additional parts for the one-tube receiver outlined in the August number cost about $6.12. The receiver described in this article is a revision of the One-tube Knockout receiver, made famous after its publication in this magazine in November, 1923.

The "Radio Lexicon" and "The Radio Primer" explain the theory involved in the receiver described and will be found very helpful to the newcomer in radio who not only wants to build a receiver that "works" but who also wants to know why it functions. Recommendation of collateral reading in the best text books is also given.—The Editor

IN THE last two issues of Radio Broadcast we have described the construction of a crystal and bulb receiver. It is now quite logical that we combine these two receivers into a reflex set, the one-tube Radio Broadcast Knockout Set that will operate a loud speaker.

Though this receiver is necessarily more complicated than those we have so far described in The Beginners' Department, the inexperienced fan will not be over taxed in its design and construction. The photographs and drawings illustrate very clearly the manner in which the set is assembled, and we shall endeavor to make these points still more plain in our descriptions.

LIST OF MATERIALS

In Figure 1	Description
No. 1	2 Variable condensers, .0005 mfd. (Hammarlund, $5.00 each)
No. 2.	2 3-inch dials (5 and 10 cts store, at 10 cts., each)
No. 3	1 Crystal detector, preferably fixed (Pyratek with mounting, $1.25)
No. 4	Rheostat, Amperite, or Daven Ballast for tube used (Daven Ballast with mounting $1.00)
No. 5	¼ pound of No. 22 s. c. c. or enameled wire (5 and 10 cts. store, 25 cts.)
No. 6	Socket for tube used (5 and 10 cts., store for UV199, 20cts.)
No. 7	Audio amplifying transformer, ratio about four to one, such as the Rauland-Lyric, Acme, General Radio, or AmerTran (AmerTran, $7.00)
No. 8	5 Fahnestock clips or binding posts (5 and 10 cts. store clips, 10 cts.)
	Cigar box, base-board, sheet of pasteboard, a few feet of bus bar and No. 18 annunciator wire, screws.

Following the mention of the parts, the exact make and price used in the receiver we are describing is given in parenthesis. This represents a total expenditure of $20.00 which can be considerably reduced, if desired, by the following substitutions purchased at the five-and-ten-cent stores: Variable condensers, 22 plates, at $1.44 apiece; rheostat at $.25, crystal detector, $.20.

THE PANEL

ONCE again the cigar-box, the mechanical genius of the radio beginner, plays the combination part of panel and cabinet. A rather large box, about ten by six inches, should be secured. The hinged cover and paper are removed by soaking in water, and the wood is sandpapered to a clean, smooth finish. The bottom of the box is marked and drilled according to the panel layout in Fig. 2. (Detailed instructions on the preparation and working of cigar-box wood are given in The Radio Beginners' Department for July.) The writer found it more convenient to take the box apart and re-assemble it as the parts were mounted.

Due to the number and size of the parts represented by the one-tube reflex set, the depth of the cigar-box is rarely sufficient to contain them all. Therefore, a large base-board six inches wide, is substituted for one side of the cigar-box as suggested in the drawing, Fig. 3. After the panel is drilled, the

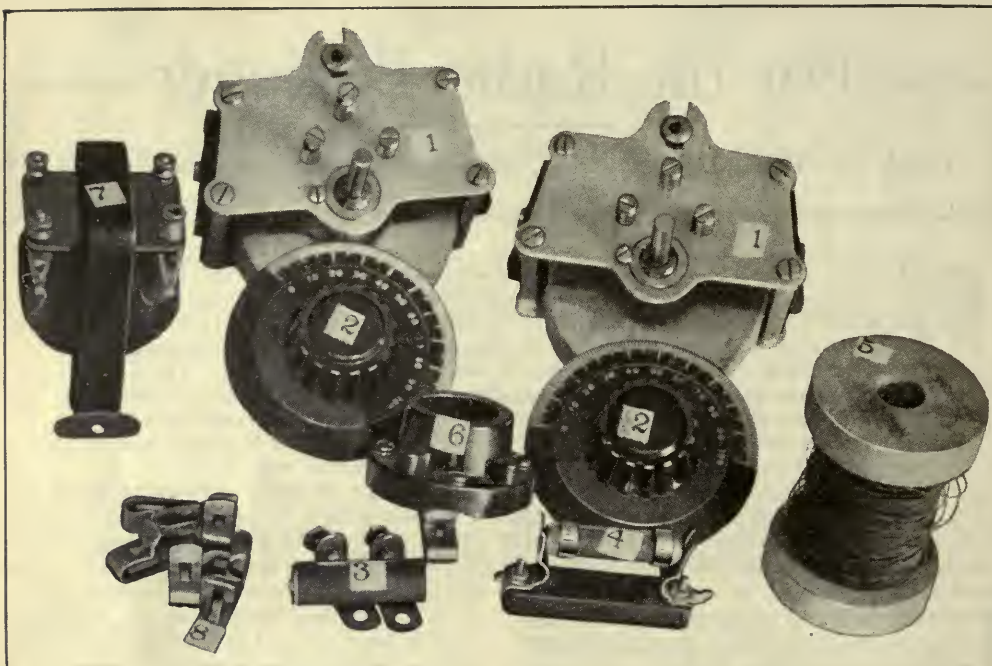


FIG. I

The purchased parts that go into the construction of the Beginners' Model of RADIO BROADCAST'S Knockout One-tube receiver

cigar-box—or what is left of it—is built up around the baseboard, three inches or so of which will project out in back of the box. The top of the box (originally a side) is nailed in place last, after the socket is fastened to it, and the condensers and coils mounted respectively on the panel and sides.

A coating of green stain applied to this woodwork will add considerably to the appearance of the completed set.

THE COILS

SPIDERWEB coils offer a simple form of inductance to the inexperienced builder, and they were chosen in the construction of this receiver. The winding form, drawn to exact size, is shown in Fig. 4. This can be cut out and traced on pasteboard, from which material the forms are cut, or the dimensions can be noted and the figure re-drawn. Two combination coils, therefore two forms, are required, designated as T1 and T2 on the wiring diagram. Two windings are placed on each form, a primary and a secondary. A small hole is punched in the cardboard, the wire inserted, and then wound over and under the spokes. This first winding is the primary. The primary of T1 has 15 turns of wire, and the primary of T2, 25 turns. At the finish of the primary winding, another hole is punched in the form and the free end of the wire slipped through. At the next spoke, just above the primary winding—a thirty-second of an inch or so—a third hole is punched, and the secondary winding begun. The secondary is wound the same way as the primary and fastened to a fourth hole at the final turn. The secondary of T1 has 33 turns of wire and that of T2, 30 turns.

Coil T1 is mounted on the left hand side of the box (looking from the front) and T2 on the right hand side. They are held in place by the wiring and by a tack, through one spoke on each coil, into their respective sides of the box.

If it is preferred, solenoid coils, such as those illustrated in Fig. 5, can be substituted for the spiderwebs. These are wound on two and a half-inch diameter winding forms. The secondaries are wound first and consist of sixty turns of wire for both T1 and T2. A layer of tape or empire cloth is placed over the secondaries, followed by the primary windings of fifteen turns on T1 and 35 turns on T2. (There are several commercial makes of transformers marketed for use with the so-called "Harkness Reflex" receiver, originally de-

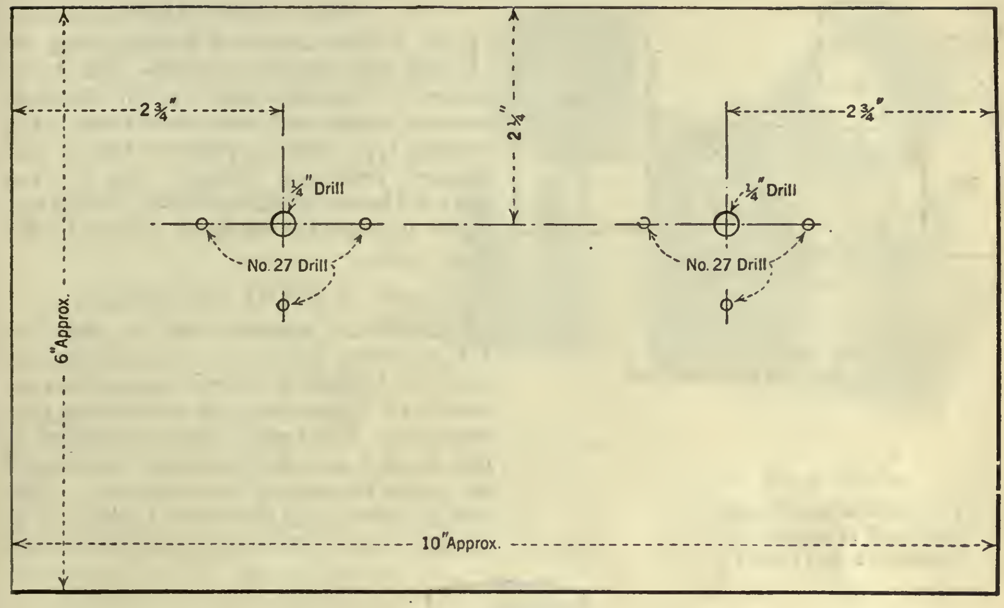


FIG. 2

The layout of the cigar box panel. The screw holes for the condensers are placed with the aid of the template furnished with the condenser

scribed in this magazine for November, 1923, which can be substituted for T1 and T2).

The socket is mounted on the top of the cabinet as suggested in Figs. 3, 6, 7, and 8. Four small holes are drilled beneath it through which wires pass, connecting to the socket terminals. No. 18 annunciator wire is used for this purpose, the remainder of the connections being made with the heavier bus bar.

All parts, excepting the transformer, can now be mounted. From left to right in Fig. 6, the following parts are seen: Coil T2, variable condenser C2. the fixed crystal detector, the amplifying transformer, variable condenser C1, the Amperite or Daven Ballast resistance and coil T1. The Fahnestock clips, from left to right are: 1, telephone receivers; 2, telephone receivers and plus B battery; 3, minus B battery and plus filament battery; 4, minus filament battery and ground; 5, antenna.

HOW TO DO THE WIRING

THE connections of the various parts are most conveniently made in the following order, with all parts, excepting the amplifying transformer T3, permanently mounted:

Filament post on socket to binding post or Fahnestock clip number 3; remaining filament post to filament resistance (R in Fig. 9), and from the filament resistance to post number 4.

Outside secondary terminal of T1 to grid of tube and stationary plates of the C1; the inside (or beginning) secondary terminal to the rotating plates of C1: The outside terminal of T2 secondary connects to the stationary plates of C2 and the inside terminal to the rotating plates.

The inside terminal of the T1 primary connects to the antenna post of Fahnestock clip number 5; the outside or finish primary terminal leads to post number 4.

The plate of the vacuum tube is wired to the beginning of the T2 primary and end of the primary to Fahnestock clip number 1.

The audio-frequency amplifying transformer, secondary to the right, is now mounted and the connections completed as follows:

The rotating plates of C2 to one side of the crystal detector, DET; the other side of the crystal detector to the P post on the primary of the amplifying transformer; the plus primary post is wired to the stationary plates of C2. The G post of the secondary runs to the rotating plates of C1 and the F post to Fahnestock clip number 4.

All joints should be soldered cleanly, and the wires bent carefully into right angle bends. The inexperienced solderer is advised to read "How to Solder" by William Crosby in Radio Broadcast for May, 1925, before wiring the One-Tube Knockout receiver.

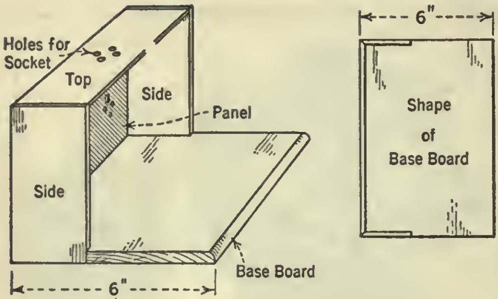


FIG. 3
Showing how the cigar box is built up about the baseboard

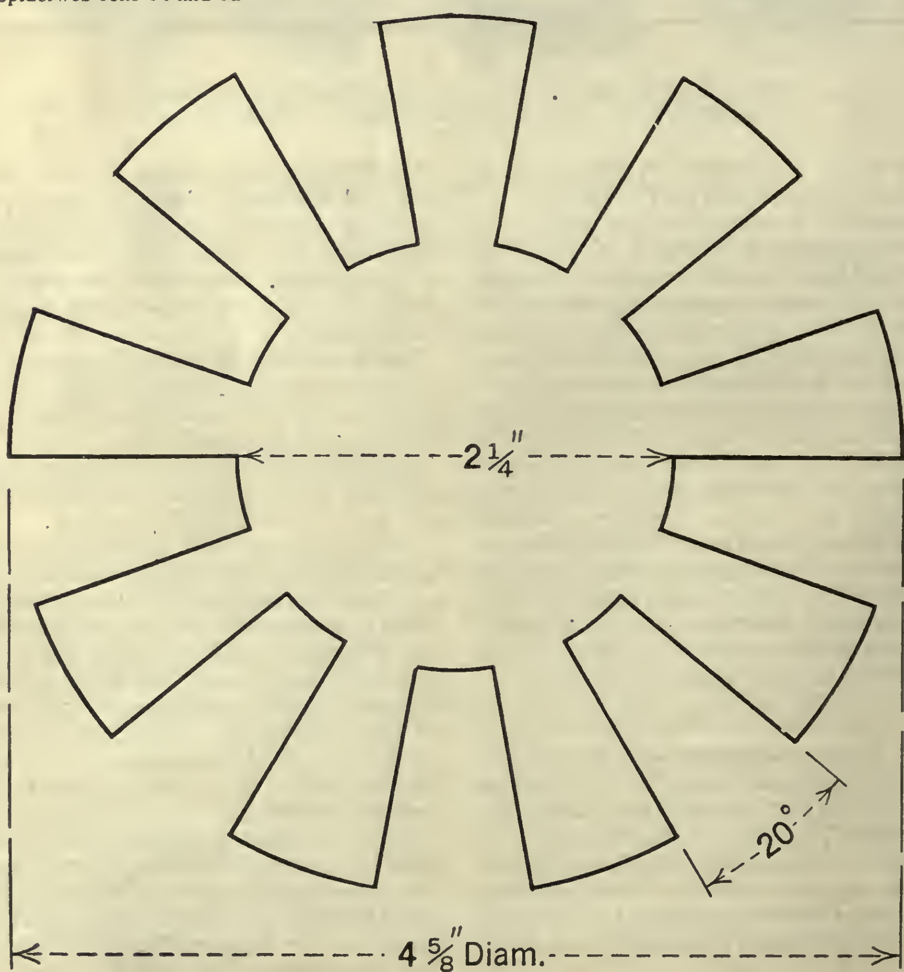
FIG. 4
Exact size of the winding form used in making the spiderweb coils T1 and T2

TUBES AND BATTERIES

THE receiver described is designed for use with the UV-199 type tube and an A battery of three dry cells. It will function, however, equally well on five-volt tubes of the UV-201A type, with the proper A battery and filament resistance. Ninety volts on the plate will be correct for both tubes, though still higher voltages can be safely applied to the larger tube.

HOW TO INSTALL THE RECEIVER

A SUITABLE antenna, such as described in RADIO BROADCAST for July for use with the Beginners' crystal receiver, is connected to Fahnestock clip or binding post number 5. The ground lead is connected to post number 4, as well as the wire leading to the minus terminal of the A battery. The plus A battery and the minus lead of the B battery connect with post number 3. The



plus B battery terminal is wired to post number 2. The telephone receivers connect to posts 2 and 1. These connections are still further explained in the wiring diagram, Fig. 8.

OPERATING INSTRUCTIONS

THE tube is plugged into the socket and the rheostat turned on, or the Amperite or Daven Ballast clipped into the mounting. The dials should be set so that they read maximum when the rotary plates of their respective condensers are fully in between the stationary plates. The two dials are now moved simultaneously over the tuning range, keeping them at approximately the same settings. When a station is heard, the controls are carefully adjusted for maximum response. If the catwhisker type of crystal detector is used, it will require the usual adjustment. Reversing the connections to the crystal detector will often increase signal strength.

Properly constructed, this receiver should give loud speaker results on local stations.

CARE AND UPKEEP

THE filament and plate batteries should be kept at the proper voltage and B batteries which show

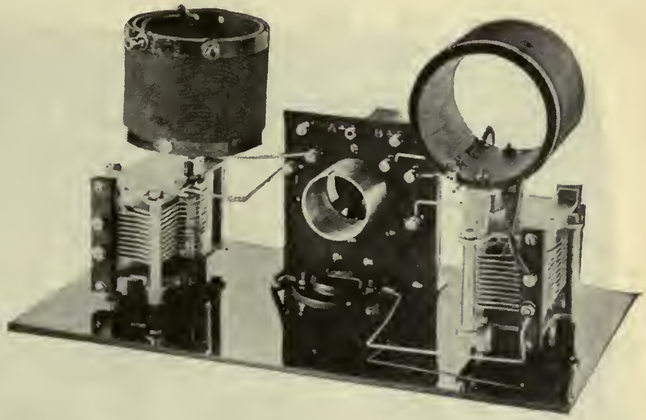


FIG. 5

The rear view of a more elaborate layout using solenoid coils. The more experienced builder will find herein plenty of play for his talent and ingenuity

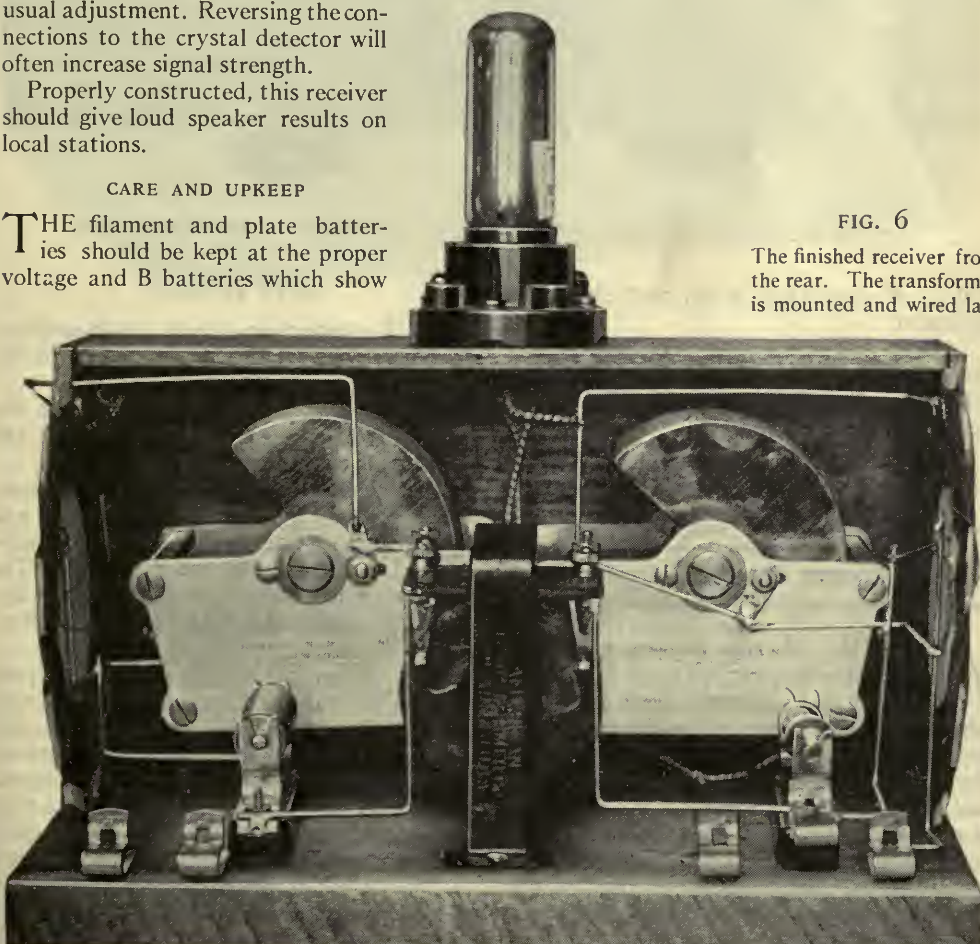


FIG. 6

The finished receiver from the rear. The transformer is mounted and wired last

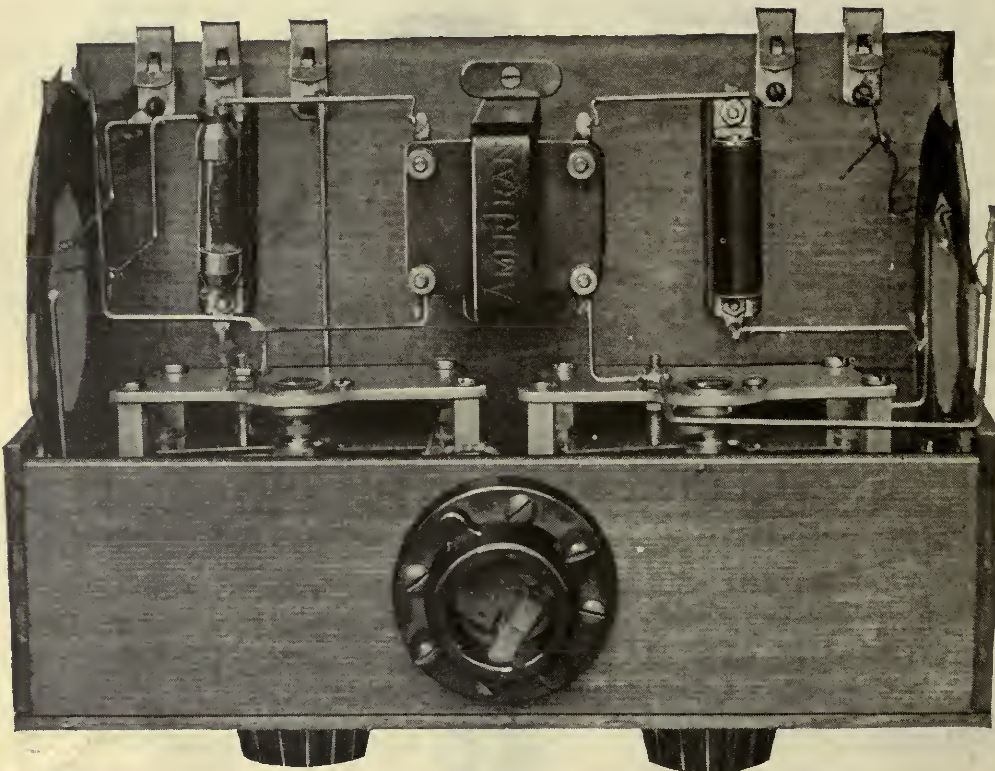


FIG. 7

Looking down on the completed set, showing the arrangement of the exposed parts

a drop of more than 25 per cent. should be discarded.

Inspect all connections occasionally and clean wiping contacts, such as in the vacuum tube socket, in order that there will be no loss due to contact resistance.

THE RADIO PRIMER

The Vacuum Tube as an Amplifier

AS USUAL in any discussion, exposition, or argument, we must have as a background a common fund of knowledge which contributes to the discussion but does not need to be explained itself. It is our starting point or premise—or perhaps the tools with which we are going to work. Most of our readers will understand these primary facts while those that do not are asked to accept them as truths, exactly as they do the assertion that the earth is round—without a personal demonstration of the undoubted fact.

WHAT WE KNOW

IN OUR explanation of how a bulb amplifier operates, we shall assume to know the following:

1. The grid of a vacuum tube is the screen-like element situated between the filament and plate.

2. Under normal operating conditions, a positive charge placed upon the grid will increase the plate current—the current supplied to the tube by the B battery. The plate current flows through the plate circuit which includes the space between plate and filament.

3. When a negative charge is placed upon the grid, the plate current is decreased.

4. An alternating current is a current that reverses its direction of flow periodically—usually many times per second. Another way of putting it is to state that any two points in an alternating current circuit reverse their polarities periodically.

5. A coil of wire passing a direct current that pulsates—grows weaker and stronger periodically—will induce in itself and in a

near-by circuit or coil, an alternating current.

6. In radio communication, we have mostly to deal with alternating currents—the high or radio frequency currents associated with the wave itself before detection (see The Radio Primer for August), and the audio frequency currents that follow detection.

FIG. 8

Front view of the finished "works." Not bad for a cigar box!

OPERATION OF THE CIRCUIT SIMPLY EXPLAINED

IN ALL multi-tube receivers, and several single-tube arrangements such as that described in this department, all tubes exterior of the detecting circuit are amplifying tubes. The tubes that precede the detector (generally a crystal or a tube) are radio frequency tubes, and those that follow it are audio frequency tubes. In other words, the tubes before the detector amplify or make stronger the radio frequency currents picked up from the radio wave, while those after the detector intensify the sound frequencies. The difference between these two frequencies was explained in this department last month.

Both forms of amplification have their respective advantages and disadvantages. Radio frequency amplification, amplifying before detection, takes advantage of the multiplying action of the detector tube, and discriminates against stray sound frequencies. On the other hand it amplifies all r. f. (radio frequency) disturbances, such as static. Audio frequency amplification provides the power required for the operation of loud speakers, but in addition to the desired signal it amplifies equally well parasitic tube noises and so forth. A judicious combination of the two systems is the closest approach to an ideal amplifying arrangement.

Both amplifying systems function in the same manner—i. e., through the repeating and amplifying action of the vacuum tube. Referring to diagram A in Fig. 10, let us assume that a radio frequency current is flowing in L_1. This would be the case during reception if this coil were the secondary of a vario-coupler or a previous amplifying transformer. Thus the polarity at the terminals of the coil, X and Y, will change periodically, depending on the frequency of the station being received. For one fraction of a second X will be plus and Y negative, and in the next instant, Y will be plus or positive and X minus or negative.

Terminal X is connected directly to the grid of the amplifying tube, and therefore the polarity existing at X for any fraction of a

second, will be immediately applied to the grid. When X is positive the plate current through L2 will increase. With the next alternation, and the reversal of polarity at X, the plate current will decrease.

Thus we have a rising and falling (or pulsating) direct current through a coil of wire, L2. Therefore, according to our fifth premise, there will be induced in L2 and in L3, which is another coil placed close to L2, an alternating current. This alternating current will be characterized by the same frequency as the original current flowing in L1. However, due to the amplifying action of the vacuum tube, *the alternating current power in L2 will be more powerful than the alternating current in L1*. The action is analagous to the comparatively weak pressure of the finger on the trigger of a gun releasing, or controlling as it were, the much greater power expressed in the exploding cartridge. As little power will be lost in induction, the energy in L3 will similarly be greater than that in L1. This magnified signal is now applied to the next tube, either the detector or another amplifier, by connecting L3 in the same manner that L1 is connected to the first tube. Thus amplification may be carried on through as many stages as is desired or expedient.

The coils L2 and L3 are combined into a single instrument or part that is designated as an amplifying transformer, of which L2 is the primary winding and L3 the secondary winding.

Transformer-coupled audio frequency amplification (amplification after the detector) is effected in the same manner, which is easily followed in diagram B of Fig. 10. Audio frequency alternating current is applied across the terminals X and Y of L1 instead of high or radio frequency current, and a magnified duplicate is caused to flow in L3. Audio frequency transformers, in order to meet the particular conditions under which they must operate, are wound on iron cores which are diagrammatically expressed by the lines between the primary and secondary coils.

AN EXPLANATION OF REFLEX CIRCUITS

IN REFLEX circuits, one or more tubes are made to amplify both radio and audio frequency currents. This combined operation

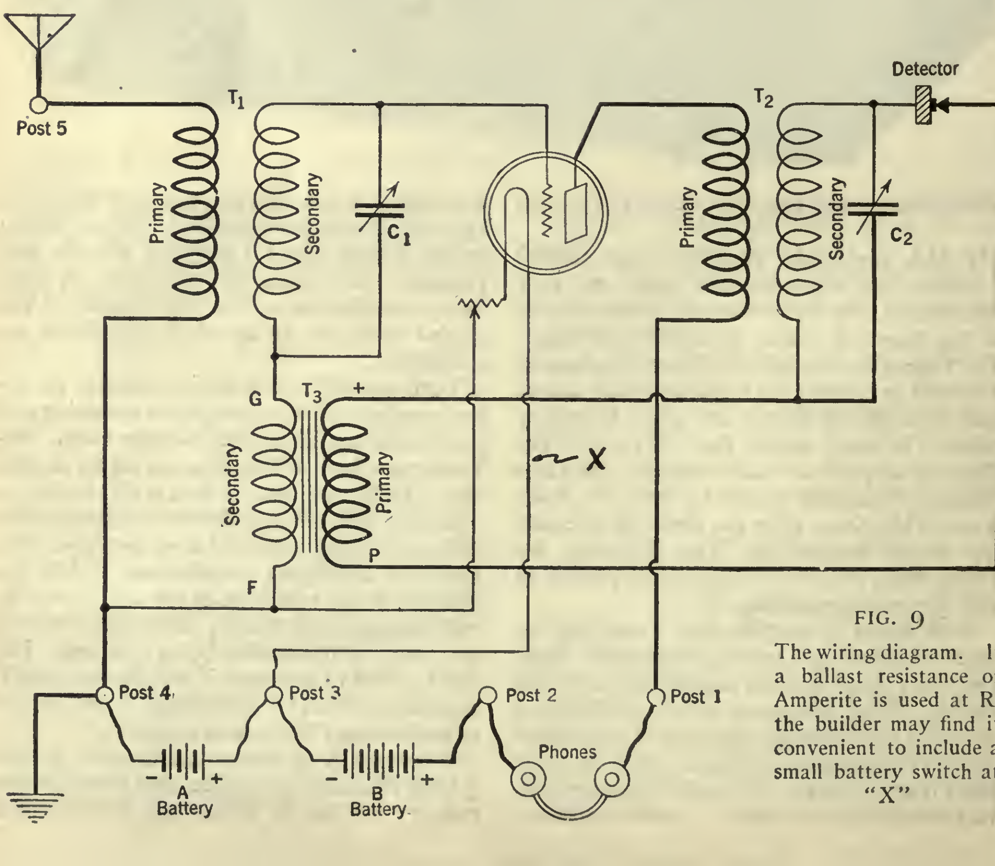


FIG. 9

The wiring diagram. If a ballast resistance or Amperite is used at R, the builder may find it convenient to include a small battery switch at "X"

will be made quite clear by tracing the operation of the one-tube Knockout receiver described for the radio beginner this month.

The radio frequency current is impressed upon the amplifying tube through the antenna coupler T1. Here the radio frequency current is amplified and applied to the detecting circuit through the r. f. transformer T2. It is detected as described in the Beginners' Department last month. The resulting audio frequency energy is now returned to the tube by the audio-frequency amplifying transformer T3 where it is amplified, and finally outputted to the telephone receivers or loud speaker plugged into the jack.

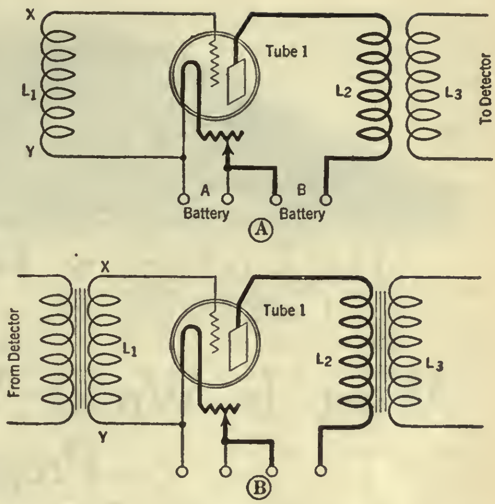


FIG. 10
Describing the action of an amplifier. The amplification is due to the relay action of the tube, the coils or transformers being merely used for the transference of energy from one circuit or tube to another

THE RADIO LEXICON

PLATE CIRCUIT: The path of the current supplied by the plate or B battery, i. e., through the B battery, the filament of the tube, across the space within the tube to the plate, through whatever coils, such as loud speaker or telephone receiver windings, transformer primary or variometer, that may be included in the circuit and back to the B battery. The plate circuits in Fig. 10 have been drawn with heavy lines.

PLATE CURRENT: The current that flows through the plate circuit. It is sometimes referred to as "space current" due to the fact that it passes across the space between filament and plate of the vacuum tube.

PERIODIC: Reccuring with equal intervals of time, such as the swing of a pendulum or the vibrations of a radio wave.

TRANSFORMER: An electrical instrument having two windings, a primary and secondary, generally placed close together, or otherwise maintained in inductive relation to each other. An alternating current of the proper frequency flowing in one winding will induce a similar current in the other.

AMPLIFYING TRANSFORMER: A transformer used for coupling the output of one amplifying tube to the input of the other. The primary of the transformer is connected in the plate circuit of the preceding tube and the secondary in the grid circuit of the succeeding tube. Special types of transformers are used in both radio and audio frequency amplification.

REFLEX: "Reflex" refers to imposing the double duty of a single vacuum tube of amplifying both radio and audio frequencies. The audio frequency output of the detector is reflexed (thrown back) on the r. f. tube or tubes.

THE RADIO LIBRARY

THE action of the vacuum tube as an amplifier will be made more clear to the enthusiast and student by reference to the following works and pages:

The Outline of Radio by John V. L. Hogan, Chapter Nine. A non-technical and highly interesting account of amplification and vacuum tubes.

The I. C. S. Radio Handbook. Pages 237 to 239. A little more technical than Mr. Hogan's chapter, but still quite comprehensible to the layman.

Thermionic Vacuum Tube by Van Der Bijl. Chapter Seven. A highly technical treatise of the vacuum-tube amplifier. This is recommended to the student with a mathematical education as is:

Principles of Radio Communication, by J. H. Morecroft, Pages 570 to 571 and 824 to 830.

The Listeners' Point of View
Conducted by Kingsley Welles

What Is Wrong With Sunday Radio Programs?

"MOST radio programs that my set brings in on Sunday are pretty bad," remarked an acquaintance of ours the other day. "There are exceptions, I admit, but the Sunday radio menu seems to be religion, served up more or less tastefully with garnishing some times pleasant and more often not." He went on to explain that he was not an unreligious person, but that he did not care to have his loud speaker blare forth things religious all day.

Well, it takes all kinds of people to make a radio audience — to give a radio twist to the common platitude about the world—and there is no question that a standardized Sunday program would not please everyone. It is impossible for anyone, even a practised program director—who, by the way, is gradually becoming known as a radio impressario—to design a Sabbath program with, say, four parts "religion," three parts classical music, and one part dance music, shake it well before using and pour the result on the air, and know he is right.

Some stations have evaded the problem of Sunday programs in the neatest possible manner by simply shutting up shop for the day. Others turn over their wavelength to a church and broadcast the entire service. Some of these add a musical program later on in the day. The truth is, of course, that most of the directors are groping, nothing less. Some of them go to absurdities, as witness WHT, the new Chicago broadcaster who announces with ill concealed pride that they broadcast special Sunday services, "The National Radio Chapel" without stop for fourteen hours each Sunday. A non-stop religious service for fourteen hours automatically goes in the same class with six-day bicycle races, and endurance dancing contests.

GOVERNOR ALFRED E. SMITH

Of New York, at his desk in Albany where he recently spoke through WGY and WJZ to the people of the State on the question of Long Island parks. Four times within the last year Governor Smith has resorted to radio to bring his ideas directly before the citizens

And on Sunday afternoon, when we search the ether lanes, we find them singularly quiet. An indifferently capable soprano here, an installment of Sunday-school music there, or nothing. Later come vesper services and music. In the evening, the variety grows. The Capitol Theatre entertainment, devised by the popular "Roxy," reaches the Eastern and Middle United States

through WEAF, WCAP, WJAR, WCTS, WEEI, WCAE, and WWJ. Ably staged, with artists of much more than ordinary ability, this program is to many the one glowing star in Sunday radio entertainment. The Goldman band concerts, reaching listeners through the same group of stations, are worth staying home for.

Dance music can be found on the air Sunday, too. However, most of the stations wait until eight or nine o'clock in the evening before their jazz musicians put lip to saxophone. Perhaps we are a bit new-fashioned, but we cannot quite agree with a correspondent who wrote us that "strains of jazz, breaking up Sunday peace and quiet, are little short of an outrage. I like radioed jazz but little at best; on week days I can stand it. On Sunday, however, I think station directors might give us one day of rest."

Dance music on Sunday via radio is not a whit more wrong than dance music on Sunday played on the phonograph or the piano. We will wager a shiny new B battery that there are few homes where a dance tune does not trickle from a phonograph or piano at least once on Sunday. It is not fundamentally wrong to play light music on Sunday. True enough, it is the Lord's Day, but aren't our ideas now of how it should be observed a bit different from those current in the Massachusetts Bay Colony in the early Eighteenth Century?

Program directors crowd their daily programs with every kind of talent known to radio, but have leaned over backwards when it comes to Sunday arrangements.

Why doesn't some enterprising broadcaster try the experiment of broadening out his Sunday offering? An instrumental concert from one to two in the afternoon would be very well received. The week day dinner concerts broadcast from a number of stations are deservedly popular. The domestic *lares* and *penates* are most apt to be guarded by the entire family on Sunday and programs aimed at the entire family would be most successful on that day.

Let us hear a traveller who knows how to describe countries and people he knows. A speaker who can talk interestingly on books and plays should be well received. The Sunday papers have a following of readers who are popularly thought to find their varied contents pleasing Sabbath reading. If the broadcasters edit their programs with restraint along similar lines, we think they would strike a very popular note.

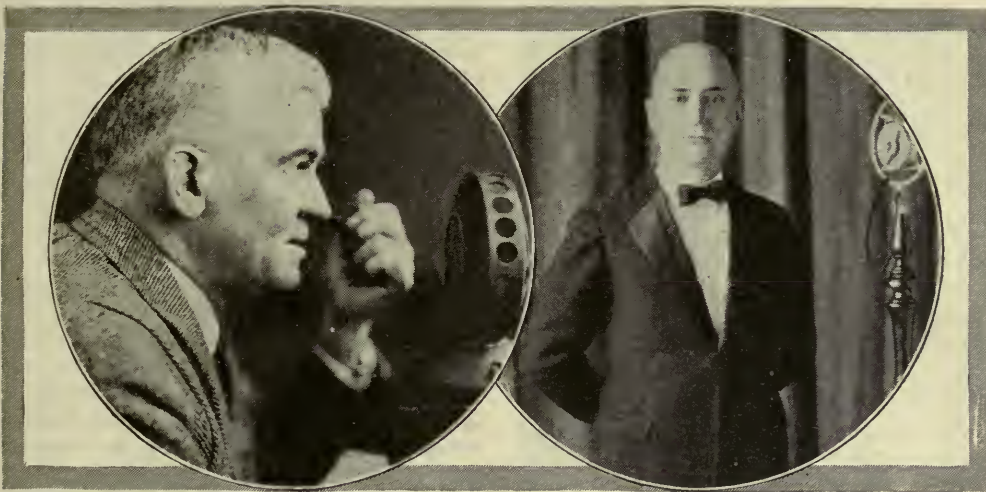
It is a mistake, by way of conclusion, to broadcast church services *in toto*. The church service is designed for the worshipper who participates by his presence. Pick-ups from churches are only moderately successful, because the highest skill of the broadcast engineer cannot overcome the reverberations always present in large church auditoriums. Result: the choir and the voice of the minister come through well, but the responsive reading and hymns sung by the congregation are fearfully muffled and usually sound like nothing human. The services run along at great length, without announcements—poor policy at best. The broadcaster discovered early that broadcasting a play direct from the stage was not satisfactory. Then came the so-called radio drama, given in the studio—a much more effective and desirable thing. For exactly the same reason, the especially prepared radio divine service is vastly more satisfactory.

BROADCASTING KITCHEN SECRETS

Mrs. Ida Bailey Allen at the microphone of WMCA, New York, telling the secret of a luscious fruit cocktail. Mrs. Allen is known throughout the country as the author of *Mrs. Allen on Cooking—Menus—Service.* Chef Louis Parquet of the Hotel McAlpin is preparing the dish and Arthur L. Lee, managing director of the hotel looks on

THE GOLDMAN BAND

Playing at the College of the City of New York. The insert (© Underwood and Underwood) shows Edwin Franko Goldman, the conductor of the Band. The concerts are broadcast on Sunday and Monday evenings throughout the summer and have proved their right to be counted among the most popular of broadcast features. They are heard through WEAF, WJAR, WEEI, WCAP, WCTS, WCAE, and WWJ



TWO PACIFIC COAST ANNOUNCERS

The "Town Crier," well known to the listeners of KNX at Hollywood, is represented in the photograph at the left, and "C. A.", Carl Anderson, one of the announcers of KGO at Oakland is the other

Quality, Quality, Who's Got the Quality?

IT IS not uncommon to hear an ardent broadcast listener say, during the reception of a program, "That sounds as if it had just gone through the wringer. Those fellows at XYZ aren't putting out very good quality." The piano "sounds terrible," or "that violin squeaks like a wheezy wheezy Ford." So go the criticisms of these indoor amateur authorities. The truth is that the quality of musical sounds and speech from the majority of broadcasting stations is quite high. Good programs of good quality are the business of the broadcaster, and it is really no secret that he attends to it uniformly well.

It is the sad truth that radio receivers in many a home are quite incapable of perfect reproduction of sounds, music, and voice. As listeners, we have really been interested in how much volume our set would deliver, rather than in the quality which issues from our loud speaker. A change is coming in radio styles and the criterion is becoming not "how loud?" but "how good?"

A listener of our acquaintance went one evening to hear an orchestra which had always been a radio favorite of his. He admitted after the experience that the orchestra did not sound natural to him. His was a case of "loud speaker ear," although he was probably unaware of his malady. He had grown so used to hearing the orchestra whose tones and overtones were made unreal by his loud speaker that when he heard the real tones they sounded entirely unnatural. His receiver and its appended loud speaker were simply unfaithful electrically. The biblical injunction to "first cast the mote out of thine own eye" applies only too well in radio. Before heaving coals of written or verbal criticism at the broadcaster, first see that there is no mote in your audio circuit.

And now that summer is here it is popular to rail at "static." It is foolish to minimize static. Every radio authority knows static exists and he knows that at times it is apt to be heavy in the summer, but being philosophical, he knows that it is temporary. Static in radio is really no more bothersome, taken by and large, than is coughing in a theatre, as some thoughtful soul once remarked. If static is bothersome during the summer, listeners may well be content with programs near by. Forcing a receiver on weak signals serves only to make the atmospherics boom in more strongly. And in passing, it is pertinent to remark that all that disturbs the listener is not static. Stray squeals and howls in a receiver are usually due not to the heavenly forces, but to some temporary indisposition of the receiver such as discharged B batteries, or to too much regeneration.

The radio listener these days no longer regards his set as an electro-mechanical wonder. He wants an instrument which he can install in his home without doing violence to his ideas of interior decoration and which he can compare with his phonograph in volume

and quality of voice and music. And now, Barkis willin', there is no reason why he shouldn't have it.

These U. S. As Others Hear 'Em

CAME, as the movie subtitles say, a letter into the office from Costa Rica the other day which phrased in interesting fashion, excellent suggestions for announcers, in which listeners not "amidst tropical heat and evergreen foliage" will heartily concur:

So far down as my country is from yours, between 1500 and 3100 miles of radius, south and amidst tropical heat and evergreen foliage, we can judge good music and good entertainment with full loud speaker. Some tiempo perhaps a sonata is on the air, an opera, a Novaes piano, a Burmerster violin, a Cincinnati bell song, or a beautiful negro glee club from Beaumont, Texas—is enjoyable, but the announcer fails to give us clearly the station or description, and that may be for the hesitation of speaking or from not toned voice, that although we can hear refined selections, we can not judge where they exactly come from.

It was suggested to Señor Amando Cespedes of Heredia, Costa Rica, the writer, that perhaps too frequent announcement of the station call would be boring to local listeners, and that the program was the thing.

"After all," Señor Cespedes wrote in answer, "are we not more interested in knowing with the beautiful program, the dear old spot on the map from which it comes? That is my reply. Radio to-day is not only yours. We down here have bought it from you, and we have a right to condense from the air the millions of frequencies that carry sweet chances, no matter if they are from jazz or from many a bad cowboy political talker."

"Sweet chances" from the air reach the ardent Costa Rican as well as the interested American. Señor Cespedes says that with his Roberts four-tube receiver he hears KSD, WGY, WSAI, WTAM, KFKX, KFDM, CYB, PWX, and KGO, who "are always very good on the air." "Davenport, WOC, is also a life constructor," he continues. "But last night, I heard KFRU, from little Bristow of Oklahoma, doing an excellent, beautiful pass time that many a broadcaster should imitate. We all do not want jazz or string noise, and as we can easily tune-out, easily too can be done by the broadcasters to pick out with good intelligence their call letters."

Señor Cespedes hopes that his "tiny Costa Rica country" may some day reciprocate with broadcasting. "Some day we will send our radio waves to you like Tuinicu, Porto Rico, or Europe are doing. Then you will hear music from the tropics, from the señoritas, from the monkies, or from our lovely bird singers; then you will feel my lovely country near you, feel our fresh air, our hurricane winds that do not harm any, you will hear our volcanos that stand proud near cities."

This "Super-Power" Nonsense

PERHAPS it is the publicity folk who are at it again, but it must be said that a lot of nonsense is being written—and worse, printed—about "super-power" broadcasting stations. When a 500-watt station increases it power to 5000 watts, the publicity men dash for their typewriters and tell the world that a new "super-power" station is now in existence, and intimate, if they do not actually say so, that forthwith any listener in Bangkok with a radio receiver assembled from a rubber boot and a tin can will be able to hear the emanations of their particular station.

"Super-power" is a term torn bodily from the electric power jargon. In that business the word means what it says. But in radio, five kilowatts is not much. Five hundred watts is about as much current as an ordinary domestic electric heater draws. It is equal to the current demanded by ten fifty-watt incandescent lamps.

When "super-power" was being debated at the last Hoover Radio Conference in Washington last October, Mr. David Sarnoff, vice-president of the Radio Corporation, very sensibly suggested that it would be more accurate to call stations operating on increased power "long range stations." And so it would. Local listeners will notice but little increase in intensity from a near-by five kilowatt broadcaster, particularly if the station be located some ten miles or more from the center of the city. At the time of writing, the Department of Commerce has allowed five broadcasters to use five kw. They are WOC, Davenport, WLW, and WSAI, of Cincinnati, WCBD, Zion, Illinois, and WCCO, Minneapolis-St. Paul. WEAF, New York, is now using 3 kw. and WTAM, Cleveland, 2½ kw, or 2,500 watts. This increase means better program service to more listeners, as Mr. Carl Dreher suggests on another page of this issue.

As many listeners know, WJZ, New York, will soon move its transmitter to Bound Brook, New Jersey, where 40,000 watts will be avail-

able, although it is probable that when the new station goes on the air late in August, that only a fraction of that power will be used.

If rumored plans of the Radio Corporation go through, radio programs during the winter will have a strong international flavor. Says General J. G. Harbord, president of that Corporation

> Within one year, American radio fans possessing the ordinary sets will be able to receive from Germany direct, through arrangements completed for broadcasting German programs through the plant of the Radio Corporation.

The foreign programs will be picked up by a sensitive receiver "somewhere in Maine," sent to Bound Brook by wire, and transferred there to the glowing WJZ tubes. During the late fall of 1924, WJZ rebroadcast some concerts from London, sent through the long range broadcasting station, 5XX, of the British Broadcasting Company at Chelmsford. These were only moderately successful, but there is every reason to believe that an exchange of good programs between the United States, England, and Germany will be an accomplished fact before the close of 1925. A Manila paper received here recently tells of the great interest in American programs. With high powered broadcasters looming on the electrical horizon, that should be possible in a year or so. So radio progresses.

BENNETT B. SCHNEIDER

At the microphone of WBZ, at Springfield, delivering one of his Monday evening talks about books and their writers. Mr. Schneider, who is manager of the Doubleday, Page bookshop in Springfield, is presenting books in a pleasantly different fashion. Instead of critically discussing a book that many of his hearers have not read, Mr. Schneider attempts to give the facts about each book which are calculated to inspire interest in reading it. His talks are on alternate Monday nights at 10:40 Eastern Summer time

Broadcast Miscellany

IT IS not unsuual for radio programs from stations on the East and West Coasts to be suddenly interrupted—almost in the middle of a bar—without any warning or announcement. Results frantic testing of local tubes, batteries, and connections to determine some unsuspected flaw in the radio machine. The stoppage of the program is almost never due to faulty apparatus, for an SOS from a ship a thousand miles away can cause an instant curtailment of every bit of radio traffic—broadcasting and ship-to-shore communication alike—with those dread code characters, ... — — — ... Broadcasting stations near the coast are required to listen-in for distress calls and stop their programs when an SOS is heard.

BROADCASTING stations receive some curious letters, ranging from those which request aid in finding lost dogs to those pleading for another playing of whatever the current version of "Red Hot Mamma" happens to be. But the request which made the most serious problem to one broadcast station secretary was this: "I live on a farm a long distance from an electrical store. Will you please write me an address of a place which will sell me a cold storage battery?"

STATION WMCA, New York, every Tuesday evening puts on a program called the "Chiropractic Hour of Music." We confess that we were consumed by curiosity to know what chiropractic music was. Perhaps there would be a saxophone sextette in which the virtuosi could show their technical training by manipulating the spine of each silvered horn. Perhaps . . . but we heard their program before speculation could proceed further. Rather well played selections from well-known operas there were. Our main disappointment came with the conclusion of the "Hour" when they closed without the expected formality of a spinal "chord"!

WE OFFER our congratulations to our contemporary, *Radio News*, on the opening of its broadcast station WRNY, atop the Hotel Roosevelt in New York. Mr. Hugo Gerns-

FRED J. TURNER

Whose "Trips and Adventures" made him many friends through WEAF. Mr. Turner is now broadcasting his weekly feature through WJZ. In the course of his radio travels, Mr. Turner has "visited" industrial plants of all kinds and many places of public interest

back, editor of the magazine and supervisor of the station, has more than an ordinary problem on his hands, for having been assigned a frequency of 1160 kilocycles (258.5 meters), WRNY will probably find it very difficult to "get out." The short wavelength stations on Manhattan Island have always had trouble working north and south, although little in the matter of radiating west. And the station, representing a periodical dealing with radio subjects, will be looked up to by radio listeners everywhere to maintain a high standard of programs. A number of experiments are being tried at Mr. Gernsback's station, one of which is the broadcasting of hook-ups, in coöperation with the New York *Sun*. Another feature is a musical signal, dubbed the "staccatone"—a flute-like note emitted before the start of a program, during intermissions, and following the last number. The announced purpose of the signal is to make it more easy to recognize the station when the words of the announcer are indistinct.

INTERESTING material about books is as rare in broadcast programs as it is in the average daily newspaper. But there are two features on the air in the East which listeners have come to rate very highly. Mr. Oliver Sayler, an authority on the theatre and a decidedly interesting speaker about books and their makers, may be heard from WGBS, New York (948.8 kilocycles, 316 meters) every Thursday evening at 8:30, Eastern summer time, And from WBZ, Springfield, Mr. Bennett Schneider, manager of the Doubleday, Page & Company bookshop in Springfield, broadcasts talks on books on alternate Monday evenings at 10:40, Eastern summer time. Reports from WBZ listeners say that Mr. Schneider's talks are received with great favor.

ANNOUNCERS have heard so much about clarity of speech and have had so many complaints about this and that and whatnot that many of them are leaning over backward in these matters, if, indeed, one can lean verbally backward. Any number of these gentry describing the evening musical progression of an orchestra stress their words, particularly "orchestra." It is almost invariably given as or-CHES-tra. Webster and other crystallizations of good verbal usage demand that the accent be placed on the first syllable. And some announcers of the Radio Corporation of America stations insist on calling their company the Radio Corporation of Amurrica—which is wholly out of place with the usually high quality of their announcing. And in passing, it should be noted that the deep-toned announcers of WGY have not yet discovered that the name of their company is the General *E*-lectric and not the General *A*-lectric Company. Small matters, these, perhaps, but mispronunciation and careless pronunciation can work wonders in spoiling an otherwise perfect program.

I'LL See You in My Dreams from WOR" was the startling information trickling through our critical loud speaker the other evening. . . . and, again, WGBS was recently broadcasting a farewell concert from a White Star Line pier in New York. A sixty-piece orchestra made up of members of the Musician's Mutual Protective Association had gathered to wish musical godspeed to Mr. Samuel Untermyer, a New York lawyer who has done a great deal for their membership. As the time for sailing neared, the parting siren of the ship and the incidental noise of departure stopped further musical broadcasting. The announcer was stalling for time, so he resorted to *ex tempore* description. "As the last siren has blown, I see Mr. Untermyer leaning over the rail of this ship . . . and now . . . the last line which holds this magnificent liar . . . this magnificent liner, to the pier is parted." Mr. Untermyer, being a lawyer, probably has been called worse names in the heat of legal controversy, but the unintentional description of the bothered WGBS announcer caused many a local chuckle.

ON JULY 4th, at ten o'clock, Eastern summer time, the War Department arranged the second national program as a climax to Defense Test Day. The entire nation was hooked up to Washington by long distance telephone lines which supplied the program to twenty-eight broadcasting stations. This, as General Salzman, Chief Signal Officer of the Army, and Master of Ceremonies for the occasion, announced, was the largest number of broadcasting stations ever to radiate a single program. Seventy thousand miles of wire were involved in the long distance hook-up. The stations participating were WEAF, WCAP, WJAR, WCTS, WTIC, WGY, WGR, WFI, WCAE, WSB, WTAM, WSAI, WWJ, KYW, KSD, WDAF, WCCO, WOC, WFAA, WOAW, KOA, KSL, KFI, KPO, KGO, KGW, and KFOA. And many of us will not soon forget the address made by General Pershing and his stirring appeal for adequate preparation for national emergencies. The program was by no means as impressive as that broadcast on September 12th last year because it was not as skillfully arranged. But even hardened radio men were impressed with the genuine drama of the affair. The success of this impressive hour must be laid directly at the door of the American Telephone and Telegraph Company, who donated their long distance wire network for the program. The technical excellence of their obscure engineers, quietly watching over the balance of those long lines, made it possible. And in time of national emergency, if ever again it comes, the President of the United States can address the entire country from his study in Washington. What would Wilson have given for such an opportunity when he made his immortal address to Congress in April, 1917!

PUTTING THE VILLAGE SMITHY ON THE AIR

Winger's Crescent Park Entertainers who are heard from WGR, Buffalo, on Friday evenings, shown playing in the village blacksmith shop at Ridgeway, Ontario, near Buffalo. In the photograph, left to right are Sam Anger, Mrs. Anger, Hugo Lautz, W. A. Winger, J. G. Willet, Ernie Clair, and Howard Brandel. The emery wheel, bellows, and forging hammer are not in use

How to Make a Universal Battery Charger

An Unusually Complete Description of a Two-Ampere Charger Consuming but 150 Watts Which Will Operate on Any Alternating Current Supply of from Twenty-Five to Seventy Cycles

By ROLAND F. BEERS

¶ *WITHIN the past year or so, radio constructors have shown a great interest in building battery chargers. An inexpensive chemical rectifier was described by James Millen in this magazine for June which has satisfied many readers who wished to construct a unit of the chemical type. The unit outlined in this article is slightly more difficult to construct, but the time and care taken in construction and assembly will be well repaid. The cost of parts, it will be noted, is only $11. The wide range of commercial frequencies covered by this device will appeal to many radio listeners who have an alternating current supply other than 60 cycles. The current consumption of this charger is quite low—150 watts on full load—and that should appeal to the home builder very strongly.*—The Editor

BATTERY chargers may be classified into three general groups: electrolytic, thermionic, and vibrator types. When adapted to charging radio or automobile storage batteries, all three types possess similar operating characteristics. Their principal function is to convert the 110-volt alternating current obtained from a light socket to direct current at proper voltages to charge storage batteries.

The direct current output of battery chargers is not uniform in magnitude but is composed of a series of individual pulses, each a half cycle of rectified alternating current as shown in Fig. 1. With the advent of each half cycle or rectified wave, there occurs a change in current from the charger, increasing and decreasing rapidly as shown by the shape of the current curve at A. Here is shown the introduction of a positive half cycle or half wavelength, of duration denoted by $\frac{1}{2}$T, where T represents the period of an entire cycle or wavelength. During this first half period, energy is fairly shoved into the storage battery. The total amount of charging energy per cycle is represented by the area beneath the curve A times the average voltage for the same period. During the second half period, $\frac{1}{2}$ T, we have a complete cutting off of the charging current, which is caused by the valve or rectifier action of the charger. If the charger is of the electrolytic or thermionic type, we may say in truth that a valve is closed to the reversed current, as shown by the flat portion of the curve at B. In the vibrator charger, a switch automatically opens the battery circuit at the end of the first half cycle in order to prevent a reversal of current through the battery. At the end of this complete wave and at the beginning of a second, we repeat the action and charging of the battery is resumed.

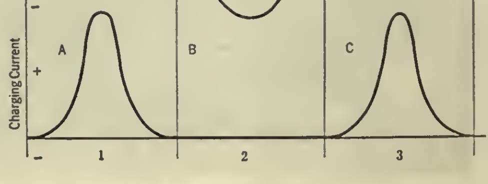


FIG. 1

A graphic representation of how a charger functions. The curve labeled "secondary voltage" shows the sine wave-form of the 60-cycle lighting circuit. That curve labeled "charging current" shows the portion of the alternating wave which is rejected in the rectifier allowing only the periodic pulsations of that portion of the curve where the current is "direct current" to enter the battery

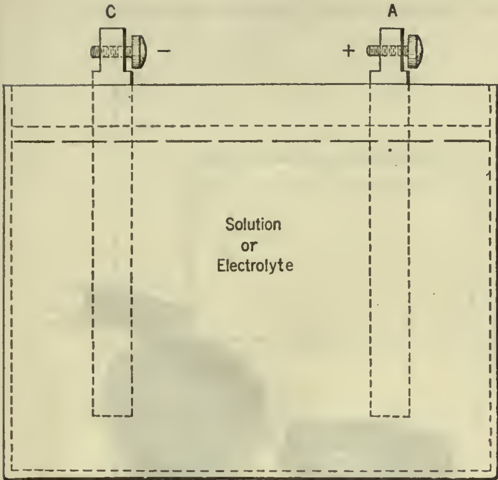


FIG. 2

A chemical rectifier in its simplest form. The positive terminal is the anode and the negative electrode is the cathode. Current may be passed from the cathode to the anode but not vice versa. Therefore, when the alternating current is on the positive half of the cycle, current flows through the rectifier into the battery but when the current is on the negative side of the cycle no current flows. This also produces a pulsating periodic flow of d.c.

NEVER CHARGE BATTERIES CONNECTED TO A RECEIVER

A BRIEF study of the character of the current supplied by battery chargers as outlined above will show why it is neither feasible nor advisable to charge storage batteries while they are connected to a radio receiver. The constantly changing battery current, when applied to the radio antenna and ground system, causes untold disturbance in the surrounding ether and may be interpreted as a form of malicious interference with radio reception. Fortunately, many charger manufacturers connect one side of the a. c. line to the output of the charger so that a house fuse is blown when the charger is operated as it is connected to a radio receiver.

Let us return to the consideration of charger design, in order to determine what are the elements with which we have to contend. The charger of lowest cost, from the point of view of home construction, could be made of the electrolytic type, provided pure metals could be procured for the rectifier electrodes. The rectifier cell illustrated in Fig. 2 consists of two electrodes, A and C, suitably suspended in a water solution in such a fashion that rectification occurs without excessive heating of the rectifier cell. The combination usually employed in home-constructed chargers is a lead (negative) and an aluminum (positive) electrode dipping into a saturated solution of common borax. Other solutions which have been used successfully for charging B batteries are sodium phosphate, ammonium phosphate, and sodium acid tartrate. One form of this charger on the market consists of an iron cup which contains the solution, into which dips the aluminum rod. Another form of electrolytic rectifier on the market consists of a tantalum electrode dipping into a solution of sulphuric acid, whose specific gravity is 1.250. The area of the tantalum electrode is 15 sq. cms. and the volume of the electrolyte must be great enough to prevent excessive temperature rise.

A TWO-AMPERE "UNIVERSAL" CHARGER

FIGURE 3 is a schematic diagram which shows the electrical apparatus and connections necessary to assemble a battery charger. Details of construction are given below for a two-ampere charger which has universal frequency characteristics. That is to say, this charger, when built in accordance with the specifications, will operate satisfactorily on commercial frequencies ranging from 25 to 70 cycles, inclusive. The design disclosed below is not perhaps the most economically constructed for use on 60-cycle current, but its cost of operation is very small and should prove no objection to the experimenter who really wants to build his own charger. In addition, the improved efficiency of operation will be of considerable

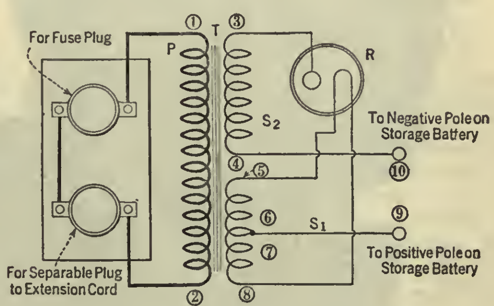
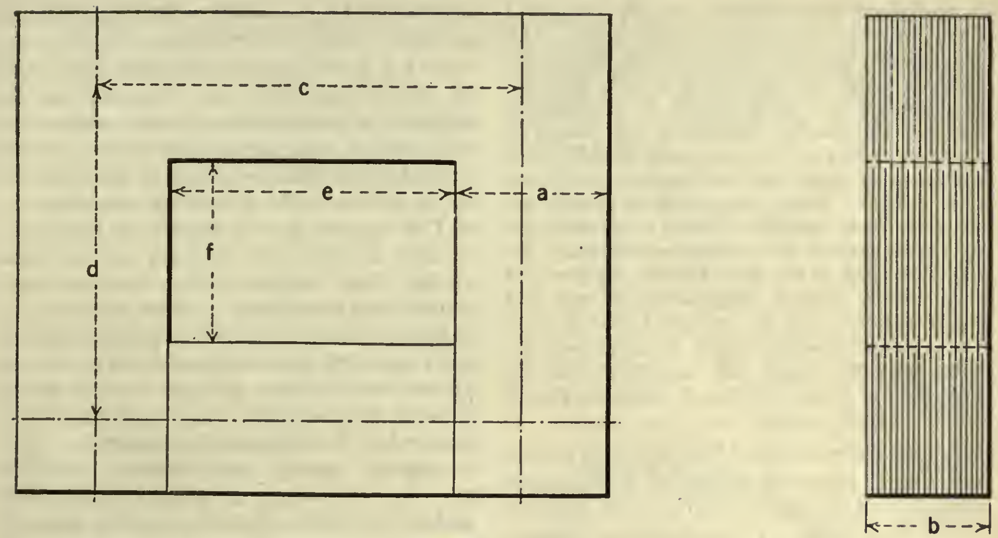


FIG. 3

The actual circuit diagram of the Beers tungar rectifier. This is different from that of the charger circuit in Fig. 10 in that a separate charging secondary is provided. Alternating current is induced into this secondary while the circuit in Fig. 10 is that of an auto-transformer employing the conductive system. There is no great difference between the two

FIG. 4
How the made-up charger looks. A bakelite panel, situated above the transformer core, supports the output terminals, tungar tube and socket and input socket with fuse block



TRANSFORMER CORE

Symbols	Author's Design
Cross-Sectional Area = a×b	2.0 Sq. Ins.
Outside Dimensions: Length = a + c	5.5 Ins.
Width = a + d	4.5 Ins.
Height = b	1.4 Ins.
Width of Steel Strips = a	1.4 Ins.
Thickness " " = t	.014 Ins.
Size of Window = e × f	4.6 Sq. Ins.
Weight of Core = (2c + 2d)(a × b) ×.28 Lbs.	8.0 Lbs.
Mean Length of Core = 2c + 2d	14.4 Ins.

FIG. 5

The details and specifications for the construction of the core are outlined here. After the core-pieces are cut, it is absolutely essential that burrs be removed from the edges and that they be entirely flat. This is necessary to obtain the required number of pieces for the specified height of the core

advantage to the battery owner from the standpoint of power consumption. The no-load power of this charger on 60-cycle supply was measured and found to be less than 10 watts. The full load power consumption was found to be 150 watts.

Fig. 3 shows a transformer with three windings, which we will designate as P, S′ and S″. P is the primary winding and is connected to the 110-volt alternating current light socket. S′ is the filament secondary and supplies the power for heating the tungar bulb filament. This winding is provided with a center tap (6-7) which will be explained in detail later. Winding S″ is the charging winding and supplies the necessary potential to operate the tungar arc. Leads are taken out from points 9 and 10 which lead, respectively, to the positive and negative terminals of the storage battery.

HOW A THERMIONIC RECTIFIER OPERATES

THE operation of the tungar or other thermionic rectifier is fairly simple of explanation. It is well known that a heated filament *in vacuo* under the stress of potential will emit electrons which will flow in the direction of the applied potential. In other words, if the hot filament be made cathode and the cold plate the corresponding anode, a stream of electrons, hence electricity, will flow from cathode (-) to anode (+). However, no current will flow in the reverse direction, from plate to filament, and in this fact we obtain the valve or rectifier action of the tube. Now when we attempt to obtain heavy electronic emission *in vacuo* (i.e. of the order of 1 ampere) we are confronted with a secondary phenomenon. Very soon so many electrons fill the space between plate and filament that they neutralize the effect of the positive charge on the plate. The result is a slowing up of the electron stream, and a decrease in the current output of the rectifier. In order to offset the effect of the space charge, as it is called, the manufacturers

of the tungar tube introduce into the chamber a small amount of inert gas, called argon. This gas is unable to unite chemically with the metallic elements within the tube, but is capable of ionization through the bombardment of the electron stream. The constant impact of the billions of electrons passing to the anode soon detaches from the atoms of argon gas their positive nuclei and their charges. When these positive charges are liberated, their immediate action is to neutralize the space charge of the tube, as established by the excess electrons in the space between filament and plate. Every positive charge attaches itself to a negative electron and the result is a neutral atom. The process of breaking up and reconstruction continues until the tungar tube is shut off, and the total effect of the ionization is to produce a greater current-carrying capacity

It may be mentioned here that the tungar and similar types of thermionic tube do not perform well on voltages above 50 on account of the irregularity in the ionization process. If it were not for this fact, the tube might be used as the rectifier element in a form of B battery eliminator, as has been attempted by the author.

We will now proceed to the construction of a two-ampere charger, as illustrated in the photograph, Fig 4. The part of the unit most difficult to construct is the transformer, but if the following instructions are carefully studied, the author believes that the experimenter will have very little trouble in obtaining successful operation from his model.

THE PARTS AND MATERIALS REQUIRED

THE following table gives the exact amount of materials required. Deviations from the design given below may require somewhat greater amounts of copper and steel, which will have to be estimated by the builder.

MATERIALS REQUIRED

8 lbs. silicon steel, thickness .018″ to .010″	$ 1.60
1 lb. No. 20 d. c. c. wire	1.00
1¼ lb. No. 15 d. c. c. wire	1.25
½ lb. No. 14 d. c. c. wire	.50
1 porcelain Edison socket	.20
1, 2-plug porcelain fuse block	.35
2 separable plugs	.30
1 2-ampere plug fuse	.05
28 inches 1 inch x ⅛ inch angle iron	.25
4 2 x ¼ inch stove bolts and nuts	.05
2 battery clips	.40
1 Fahnestock clip	.05
6 feet twisted lamp cord	.15
4 feet rubber covered No. 14 flexible cord	.25
1 2-ampere tungar rectifier tube, list	4.00
1 bakelite panel 4 x 7 inches	.25
	$10.65

Prices given above are the highest retail prices experienced by the author. Most builders have access to materials at lower cost.

In Fig. 5 are given the complete dimensions of the transformer core. In view of the difficulty with which the average amateur obtains silicon steel sheets such as are necessary to make this transformer, a few remarks may be of service in the process of construction.

The simplest way to obtain the steel laminations for the core is to go to your local electric light company office and ask for a junked pole transformer of from 1 to 5 k. v. a. capacity. Such transformers are often thrown away and are frequently sold for $1 or less. If you are fortunate enough to obtain one of these burned out units, your problem of finding steel of the right quality is solved.

Another equally good source of silicon steel is from amateur supply houses who make a specialty of furnishing this material to transmitting amateurs. Advertisements of these firms are carried in current radio periodicals. The price is generally less than 20 cents per pound in 10-pound lots.

Assuming that you are still unable to obtain silicon steel of approximately .014 inch thickness (limits .010 inch to .018 inch), get in touch with transformer manufacturers or steel jobbers, from trade journals which are frequently on file in public libraries. Many times the author has received extreme courtesy from such firms who are willing to accommodate their inquirers with small quantities of scrap steel.

As a last resort for core material, go to your local tinsmith and get the best grade of soft sheet iron or steel he has. For the 60-cycle design outlined below, use exactly the amount of soft iron as is specified for the silicon sheet steel. For the lower frequency design, such as 25 cycles, use one half more cross-sectional area in the core. For example, using soft iron on 25-cycle chargers, we would build a core measuring in cross-section 1.8 inches x 1.8 inch or the equivalent, instead of the core as specified, which measures 1.4 inches x 1.4 inches. For frequencies intermediate between 25 and 60 use a direct proportion to obtain the proper amount of soft iron. However, the author strongly recommends the use of silicon sheet steel, if it can possibly be obtained.

MAKING THE CORE FROM POWER TRANSFORMER PARTS

IF YOU have obtained a junked transformer, place it near a hot stove or furnace for half a day in order to soften the filling compound.

Having removed the cover, attack the bolts which hold the core to the case. Remove these, together with as much of the black filling compound as possible and dump out the transformer on to a pile of old newspapers. If the core can now be taken out of doors and washed with kerosene, most of the black compound can be cleaned off. With a heavy block of wood or wooden mallet, drive out the core from the center of the windings. A convenient way to do this is to block up the windings on two 2 x 4-inch pieces while you are hammering on the core in the attempt to start it. Once loosened, the entire core can be pushed out when it will fall into bunches of steel laminations. These should be carefully separated and cleaned off with kerosene or carbon tetrachloride. Avoid bending or breaking any of the pieces, as you may need them all during the construction of the charger.

Most power transformers are made up of U-shaped pieces and straight pieces, as shown in Fig. 6. If you are fortunate enough to obtain such pieces as these, your core construction will be very simple. The dotted line shown at c—c, Fig. 6, shows how the steel laminations can be cut down to make the proper sized core. End pieces (shown at s) can be cut from the waste to make a closed rectangle. When cutting the steel for the core, extreme care should be taken in obtaining a perfectly tight fit, at g Fig. 6. If the cutting is done by hand, only very large shears should be used and each strip should be accurately measured and marked out before cutting. Carelessness in assembling this part of the charger may result in its failure to operate. The best way to cut the pieces for the core, regardless of their shape, is to take the entire lot of steel and your pattern to the local tinsmith's shop, where you will find squaring shears that may be used to great advantage in obtaining square edges. Often the tinsmith will let you do your own cutting, unless he is cautious in preventing accidents. In either event, the entire lot of steel can be cut out in this manner in less than an hour.

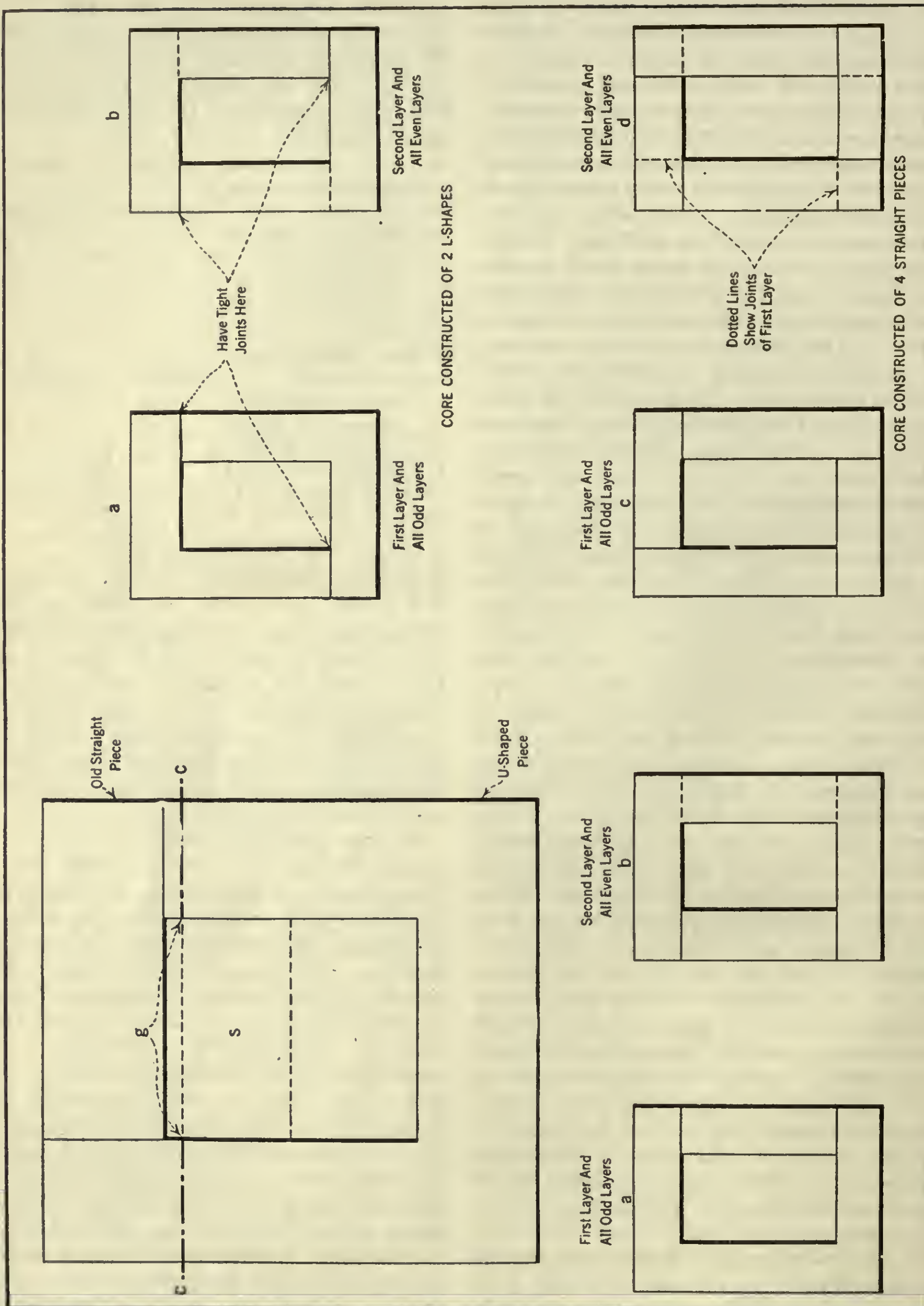
In case you have been unable to obtain the U-shaped pieces for the core, you may possibly get enough steel from the old transformer to make up the charger core in other ways. Fig. 7 shows the possibilities that may occur with commercial transformers, and the ingenuity of the experimenter will serve him in assembling the right amount of core material. Fig. 5 shows the dimensions recommended for an efficient two-ampere charger on all frequencies. On account of the variations in the sizes of steel laminations available, it may be impossible to adhere to these dimensions exactly. For the benefit of those who do find these variations, the following limits will be helpful:

	min.	max.
1. Cross-sectional area of core—a x b . may be, as shown, 1.4 ins. x 1.4 ins. or 1 in. x 2 ins. or 2 ins. x 1 in. etc.	2.0 sq. ins.	2.0 sq. ins.
2. Mean length of core —2c + 2d . . where c and d are measured along center line of core	12.0 ins.	6.0 ins.
3. Area of window—e x f —(c + a) (d + a)	3.8 sq. ins.	4.6 sq. ins

FIRST CORE ASSEMBLY

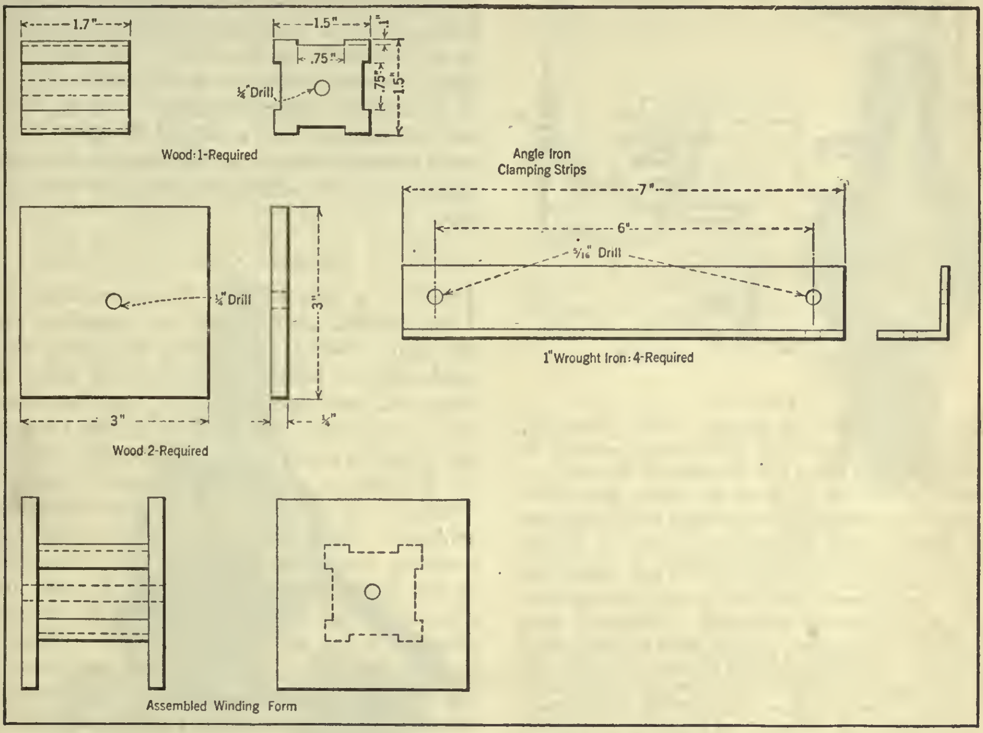
HAVING determined the size and shape of the core within the limits specified above, the pieces are temporarily assembled to determine if enough steel has been cut out. Piles of each leg or half core are stacked up and clamped up in a vise so that the actual core height (b) can be measured. When sufficient steel has been prepared, the outside measurements and cross-section are taken and noted for future reference.

We now proceed with the winding of the coils P, S′ and S″. The first thing to do is to cut from a block of wood a piece shaped exactly like the section of the core which is to contain the windings (see Fig. 8). Dimensions shown are for the design recommended by the author. Whatever changes are necessitated by variation in steel sizes must be calculated by the builder. The winding block should be approximately 0.10 inch larger than the maximum width and height of the core in order to facilitate application of the completed windings. Slots 0.75 inch wide and 0.10 inch deep are cut longitudinally along each face of the block, in which strips of friction tape are laid before the winding is begun. A hole is drilled through the center of the block large enough to pass a $\frac{1}{4}$-inch stove bolt for clamping the block in a chuck. Two pieces 3 inches x 3 inches are now cut from $\frac{1}{4}$-inch stock to provide heads for holding the winding in place as it is wound. Quarter-inch holes are also centered in these pieces as shown in Fig. 8. The winding form and spool heads are now assembled upon the $\frac{1}{4}$-inch bolt, and a nut



FIGS. 6 AND 7

Several types of transformer cores which may be employed in this construction. The sketches are self-explanatory



FIGS. 8 AND 9

Details of construction for the coil winding form and iron angle pieces. It is to be noted that many of the dimensions are indicated in decimals and it is urged that constructors adhere to these specifications

clamps the entire form together as shown in Fig. 8. The protruding end of the stove bolt is clamped in the chuck of a breast drill, hand drill, or carpenter's brace preparatory to winding the coils. Four pieces of ¾-inch friction tape are cut approximately 6 inches long and laid squarely in the slots provided for them. The long ends of the tape are drawn up over the edge of the spool heads and stuck together in one spot near the center of the spool heads. A strip of heavy Manila wrapping paper is now cut four feet long and as wide as the distance between spool heads. Fig. 8 shows this strip, 1.7 inches wide. This strip of paper is tightly wrapped over the winding form after gluing the first end in place. If the builder sees fit, he may apply a thin layer of glue continuously over each layer of paper so that the paper shell when completed will serve as a firm support for the coils.

WINDING THE COILS

THE primary winding is wound first and consists of 570 turns of No. 20 d. c. c. wire, wound in smooth layers. The first end of the primary winding is brought up the side of the spool and is later taped in place by means of one of the adjacent strips of tape. Approximately 24 turns per inch should be wound and pains should be taken to wind the wire as smoothly as possible, preventing overlapping of adjacent turns. When the winding is completed, the end of the wire is left about eight inches long as a terminal to connect to the flexible extension cord or terminal block as shown in the photograph. The long ends of tape which have hitherto been fastened to the spool ends are now drawn tightly over the winding and fastened in place. The spool heads are removed and the entire winding is now taped securely with one layer of friction tape, half lapped. The coil is now ready for assembly but before we can put the laminations in place, we must prepare the second coil which has two separate windings, S′ and S″.

Winding S″ consists of 150 turns of No. 15 d. c. c. wire wound in the same manner as P. Terminals are brought out each end of the coil, each consisting of about eight inches of the same wire used to wind the coils,

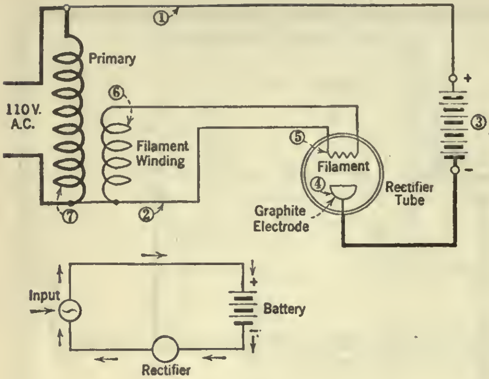


FIG. 10

How the tungar tube rectifies. The transformer primary (7) induces into the filament winding (6) a voltage for lighting the filament of the tube (5). When the battery (3) is in the circuit and current turned on, an arc is set up between the filament and the graphite electrode (4). When the line (1) is positive, current flows through it to the battery and through the electrode (4). Then through the arc to the filament and back to the other side of the line (2) completing the circuit. However, when the line (1) is negative, current tends to flow into the bulb from the filament to the graphite electrode, but as the resistance offered to the flow of current in this direction is very high no current will flow through it to the battery. Therefore, periodic pulsations of current in the right direction of flow is passed through the battery changing the chemical composition of its negative and positive plates thus restoring them to their original charged condition. This is a simple rectifier circuit of the standard manufactured type of tungar rectifier. Both this type and that described by Mr. Beers produce the same results

No. 15 d. c. c. One layer of friction tape is wrapped securely over S″, and then winding S′ is applied, which consists of 11 turns of two parallel No. 14 d. c. c. wires with a tap at the $5\frac{1}{2}$ turn. For convenience in winding this coil, the half pound of No. 14 d. c. c. which the builder has purchased is divided into two equal lengths which are wound together on one spool preparatory to winding the parallel strands. Then as the spool is unreeled during the process of winding, it will be a simple matter to maintain the two wires parallel at all times, and to avoid their twisting or crossing each other. The tap brought out at the $5\frac{1}{2}$ turn should be a loop taken in the two wires at the same point, and should be in length about two inches. This tap is later cleaned thoroughly and a generous coating of solder is applied to form a lug of large current-carrying capacity. The end terminals of this winding (S′) are treated in the same manner and are left of such a length that they can be carried directly to the screws on the Edison socket without splicing. It is important that this circuit be of very low resistance (i. e. less than one ohm) so that it will carry the filament current of 4 amperes without heating. The finished coil, containing the windings S′ and S″ is now removed from the winding form and taped with one half-lapped layer of friction tape.

HOW TO ASSEMBLE CORE AND WINDINGS

IN FIG. 4 may be seen the appearance of the finished coils as they are assembled on the core. When assembling the core, the steel strips or laminations should be inserted from first one side and then from the other so as to alternate the position of the air gap in the core at every layer. Figs. 6 and 7 show the position of the various types of laminations and the manner in which they should be arranged. Care should be taken when assembling the steel core that the insulation on the windings is not damaged to such an extent that turns of wire may become short-circuited to one another or to the core. When nearing the top of the core, place the partly assembled transformer in a vise, compressing the laminations as much as possible, and then squeeze in a few more pieces of steel. It may be necessary to hammer the last one or two pieces in place in order to obtain the necessary cross-sectional area of the core, but the operation should be attended with great care lest the coil windings become damaged.

The completed transformer is clamped together between four pieces of one inch angle iron or hard wood strips as shown in Fig. 9. One-quarter inch stove bolts, two inches long are needed for the transformer design shown in Fig. 5; others may be supplied by the builder to suit his individual requirements. The completed transformer should now be given a coat of black insulating paint in order to preserve the appearance and prevent rusting of the iron parts. It is advisable to paint the lead wires as well, in order to improve the effect of the insulation on them. For want of better insulating paint, the author used automobile enamel, which has withstood the heating effect of the charger remarkably well.

We are now ready to assemble the charger in whatever manner seems advisable to the builder. If he desires, he may cut a baseboard of $\frac{1}{2}$-inch hard wood, measuring 7 by 8 inches, and all parts may be assembled on this base in a compact manner. A more shipshape assembly, and one which leads to a

more commercial appearance, is illustrated in Fig. 4, where a terminal board of $\frac{1}{4}$-inch bakelite 4 by 7 inches is mounted on the top of the transformer and contains the tungar tube socket, battery terminals and fuse block. The terminal board is set by brass bushings $\frac{1}{4}$ inch above the angle iron brackets and holes are drilled for mounting the various equipment and for passing the lead wires up to the proper terminals. This method of assembly and wiring, suggested by H. F. Mason, is very compact and neat, as may be seen from the photograph, Fig. 4.

FIG. 12

A typical rectifier tube. The screw-base allows it to be inserted in a standard lamp socket from which current is obtained for the filament. Connection is made to the graphite disc by means of a Fahnestock connector which clips on to the wire post projecting from the other end of the tube

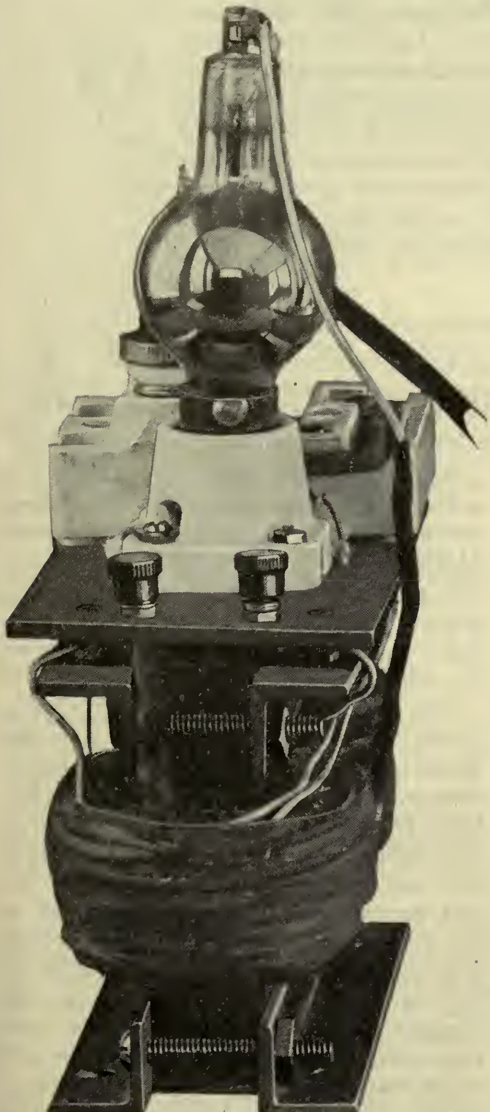


FIG. 11

Another view of the completed charger. This is an end-view picture and shows how the angle pieces are employed not only to hold the core together but as feet and supports for the bakelite shelf

The porcelain fuse block serves two purposes: as a fuse holder for the two-ampere fuse and as a terminal block for the 110-volt extension cord. Wiring and connections are made in accordance with Fig. 3. Leads to the storage battery clips should be of No. 14 stranded rubber covered wire, and if a twin conductor cable is used, a polarity indicator should be provided. For want of a better indication, the terminal leading to the positive battery terminal may have a knot tied in it, or it may have a red string tied to it. The 110-volt extension cord may be of ordinary lamp cord.

FINAL INSTRUCTIONS

WHEN the charger has been assembled and connected to the battery for charging, inspection should be made to observe the initial performance. If possible, the charging rate should be measured, if only by means of a Ford dash ammeter or similar device. When charging a 6-volt storage battery, the rate should be 2 amperes; on a 12-volt battery the rate will be 1 ampere. If the charger delivers less current than the above amounts, and still gives some current greater than zero, turns should be added to winding S″ until the proper rate is attained. The percentage of turns it is necessary to add may be calculated from the percentage deviation from the normal charging rate. In case the charger fails entirely to operate, first look for loose wires or broken connections. Then try reversing the battery leads or clips and observe if charging ensues. Occasionally it will require the addition of several turns of wire to winding S″ in order to obtain satisfactory starting of the tungar arc, but this should be necessary only when the transformer has been assembled or wound care-

lessly. The extra turns are then necessary to offset the excess leakage flux from the transformer core.

When the charger has been adjusted so that it does charge at the proper rate, it should be left charging for at least two hours under inspection before it is pronounced satisfactory. During the inspection period, tests should be made of the core and coil temperatures. They will normally run at such a temperature that the hand can just be held upon the hot parts without burning. Occasionally a charger will be found that will blister the hand if left on more than 15 seconds, but this charger is running at a high loss. If the temperature of any of the parts become as hot as this, look for short-circuited turns, low quality steel, or careless assembly of the core. Any of these three points will in itself be sufficient to warrant rebuilding the transformer.

INTEREST among radio constructors is very strong in the problems offered in the design and construction of chemical plate supply units. James Millen, in the June RADIO BROADCAST, *described an inexpensive chemical plate supply unit which has been built by a large number of experimenters. Another article by Mr. Millen will appear in an early number of the magazine. It will discuss the problems encountered in his and other chemical rectifiers, and answers to many queries about variation in the use and design of this unit.*

The New Transmitting Station of "Radio Broadcast"

FOR the past three months, the Laboratory of RADIO BROADCAST has had a short wave transmitter in operation. The beginnings have been modest, for the antenna is supplied by a fifty-watt tube, operating on a plate voltage of 1100. A wavelength of 40 meters is now in use, although in the near future the station will also be operating on the lower waves at present permitted in the amateur communication band. Although various methods of plate supply have been tried, the transmitter is now operating from a bank of B batteries, and a good deal of experiment is in progress with the problems involved.

Since the call letters of the RADIO BROADCAST station, 2GY, were assigned, a large number of cards from amateurs who have heard our signals have been received. Since 2GY is listed in the current Government list of United States amateur call letters, practically all of the cards announcing the successful hearing of 2GY have been sent to Mr. F. X. Hayes, 162 East 82nd Street, New York, the former possessor of that call.

Amateurs who hear our station are asked to address their cards to the Director of the Laboratory, RADIO BROADCAST Magazine, Garden City, New York. We are very anxious to have complete reports from any listening amateur who will be good enough to send them to us. An acknowledgement will be sent in reply.

The transmitter in its present experimental stage, has a dependable daylight range of between eight hundred and a thousand miles. Communication has been established with many radio amateurs who are located within a thousand-mile radius of Garden City.

A number of interesting experiments in short wave transmission are in progress, and in later numbers of this magazine they will be described. It need not be thought by the broadcast listener that transmitting experiments of this sort are uninteresting to him. On the contrary, some of the most fascinating experiments being conducted in radio to-day lie in the field of short waves. Many of the problems to be solved in this work are very similar to those in the broadcast field.

Shall I Run My Set from the Lamp Socket?

RADIO BROADCAST Laboratory Analyzes Devices Commercially Available to Help Operate Receivers from Alternating Current — Helpful New Devices from the Manufacturers for the RADIO BROADCAST Phonograph Receiver

BY THE LABORATORY STAFF

¶ *EACH month, the* RADIO BROADCAST *Laboratory will bring to its readers some of its findings in the field peopled by the manufacturers. The purchaser of radio equipment has little chance to find out what is wheat and what is chaff among the material that is for sale—that has become one of the tasks of the Laboratory. It is obviously impossible to test in the Laboratory, to illustrate, or even mention, all radio equipment which appears for sale. The apparatus mentioned in these pages is neither all that has been tested nor that which we believe to be the best on the market—it is merely representative equipment. Nothing in which the Laboratory does not believe will be described, nor will advertisements of poor apparatus coming from unreliable concerns be included in this magazine.*—THE EDITOR

AT THE present time, there are two types of apparatus for sale to the radio public that operate from the light socket, battery chargers and battery eliminators. Of the chargers there are three kinds, depending upon the type of rectifying element that is used—whether vacuum tube, chemical, or mechanical. Of the eliminators, there are only two, since a mechanical rectifier has not, as yet, put in its appearance. These two types eliminate only the B battery, although manufacturers promise that the near future will see devices which will eliminate the A battery as well. It is only a question of time until it will be possible to get A, B, and C batteries from a light socket.

Tube battery-chargers consist essentially of a transformer to change the alternating voltage current to the proper value to operate the tube and deliver the charging current; a Tungar or Rectigon two-element tube, which is the rectifier element, changing alternating current to pulsating direct current; and certain resistances which are required to reduce the voltage to the proper value for charging A or B batteries.

The Acme charger, which is illustrated, was sent to the Laboratory for test and after performing well all winter still pushes two amperes into the Laboratory batteries. Similar chargers are made by others, and those sent to the Laboratory by the Westinghouse and General Electric companies are examples of a very high grade of electrical equipment.

Chemical chargers have a transformer and one or more jars of solution in which are two metallic elements. Current will pass through the affair in one direction but not in the other. The Balkite charger, now in the Laboratory, may be used when the receiving set is in operation—provided the battery is not too low in charge.

Mechanical chargers have vibrating contacts which permit current to flow into the battery in the proper direction at the proper time. They make a a humming noise in operation, and like all other A battery chargers, their efficiency is about 25 per cent. when in actual use. In other words, 75 per cent. of the power put into the charger disappears there and only one fourth gets into the battery.

The Full-Wave Charger made by the Liberty Electric Corporation of New York City has been in use in the Laboratory and is a fast worker. The Ward-Leonard variable resistance in the photograph is used to lower the output voltage so that B batteries may be charged at various rates not to exceed one third of an ampere. A lamp may be used in place of the resistance, the size depending upon the voltage of the battery to be charged as well as the rate desired.

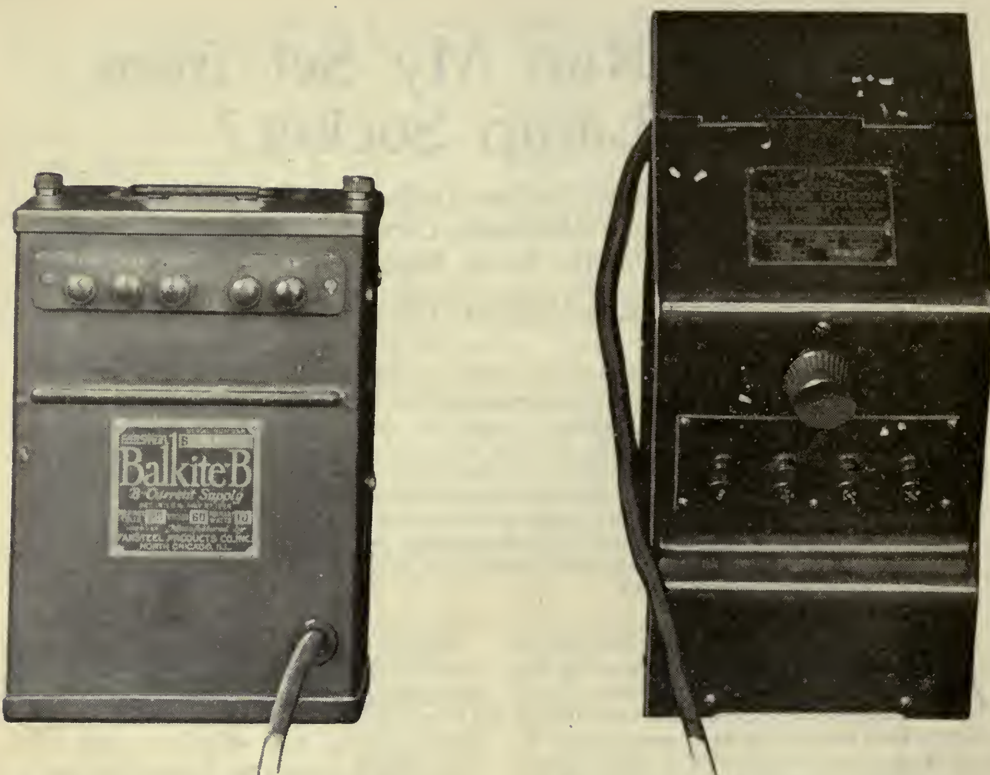
BATTERY ELIMINATORS

THERE is great interest in battery "eliminators" at the present time. The more important questions to be asked by a prospective purchaser are:

1. Is the eliminator effective?
2. Is it economical?
3. How long will it last?
4. Is it quiet in operation?

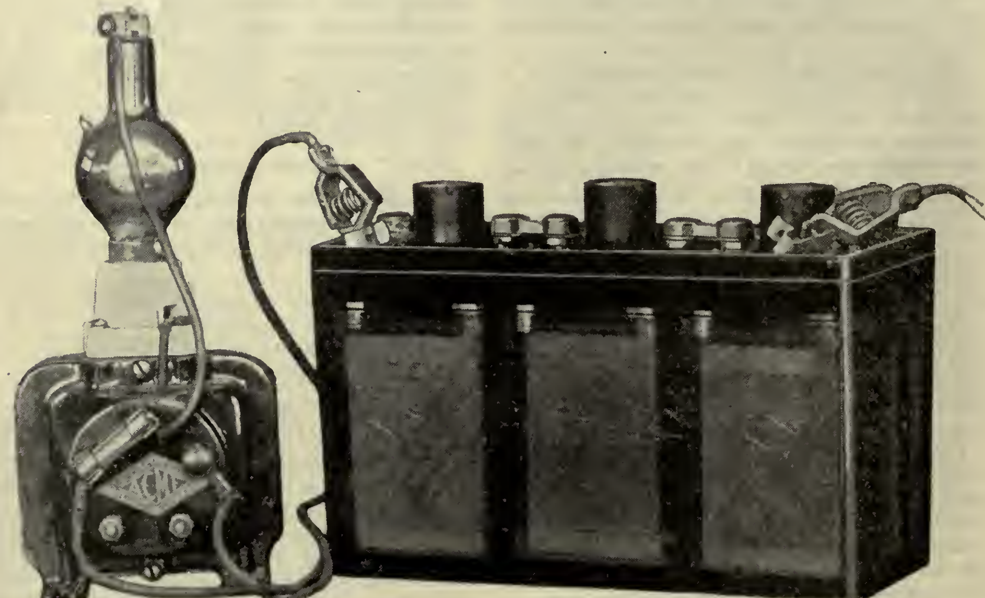
All eliminators consist of a transformer, a rectifying device, and a filter. The transformer boosts the 110 volts a. c. to whatever voltage is required so that the output is about 90 volts after accounting for the voltage drops in the rectifier and the filter.

Tube eliminators employ standard 5-volt, three-element receiving tubes, or special two-element rectifier tubes, and are high resistance devices. In other words, the more current that is drawn from

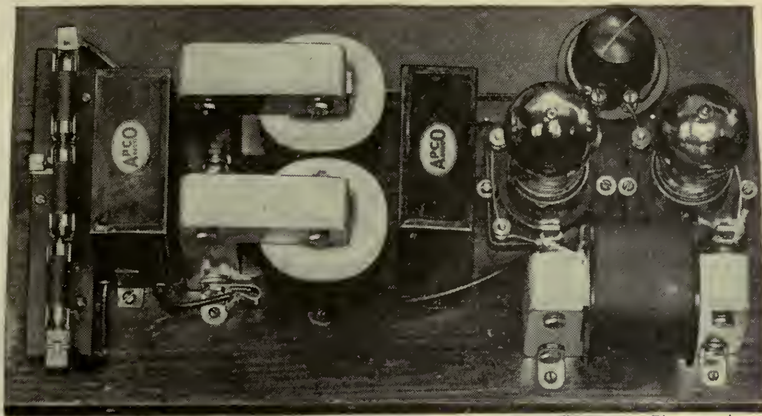


Radio Broadcast Photograph

Substitutes for B batteries are of two kinds, and here are examples of both of them. The Balkite device uses a chemical rectifier and is made by the Fansteel Products Co. The Super-Ducon uses a vacuum tube as the rectifier and is made by the Dubilier condenser people. The photo below shows the Acme charger with a Philco A battery. All have been in use in the Laboratory.



Radio Broadcast Photograph

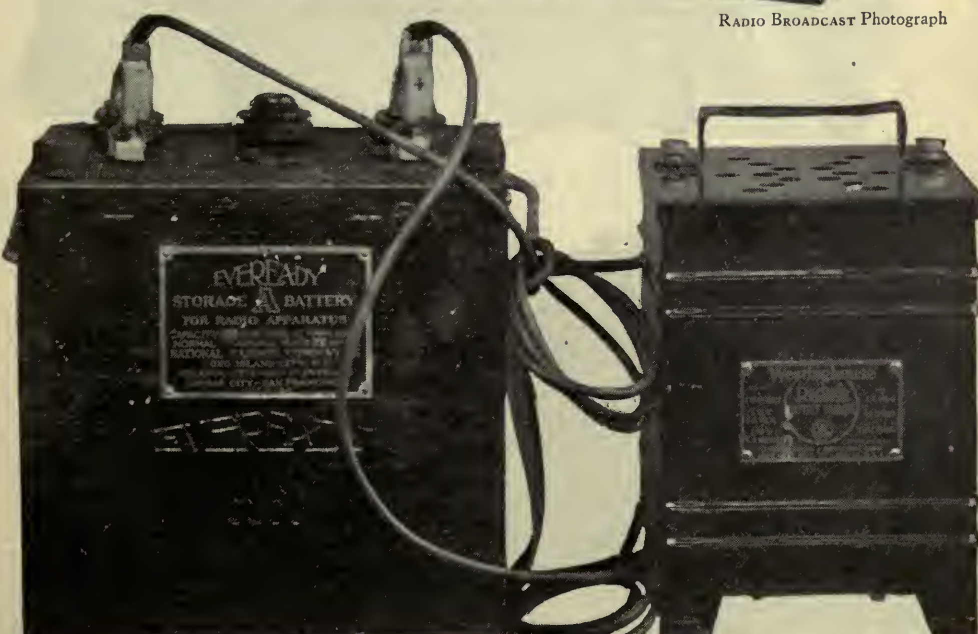


The Apco B substitute using two rectifier tubes, and a convenient layout of accessory apparatus

RADIO BROADCAST Photograph

The transformers below for transforming 110 volts a. c. to the voltage required for other purposes are made by the Dongan Electric Mfg. Co., and the Radio Foundation

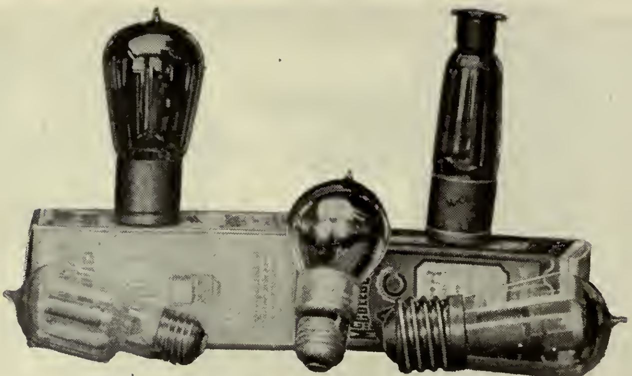
RADIO BROADCAST Photograph



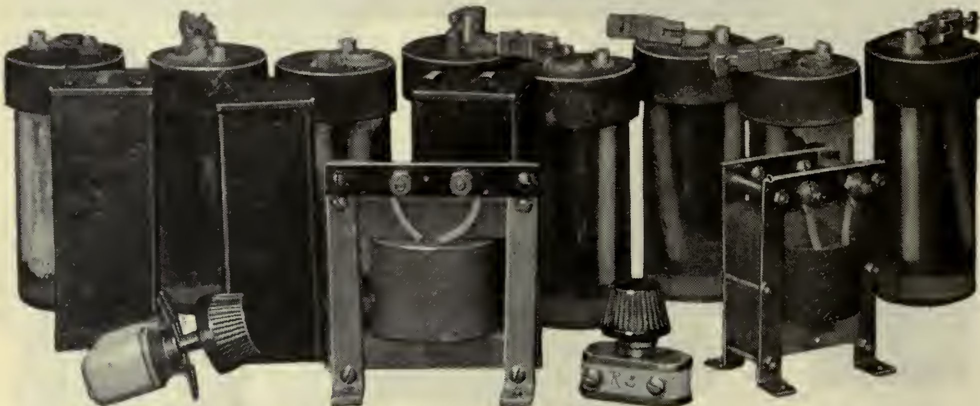
RADIO BROADCAST Photograph

Two electrical instruments from well known manufacturers. The Eveready A battery and the Westinghouse A battery charger—which will also charge B batteries

The A. C. tube together with several rectifier tubes which serve the various purposes outlined in the text

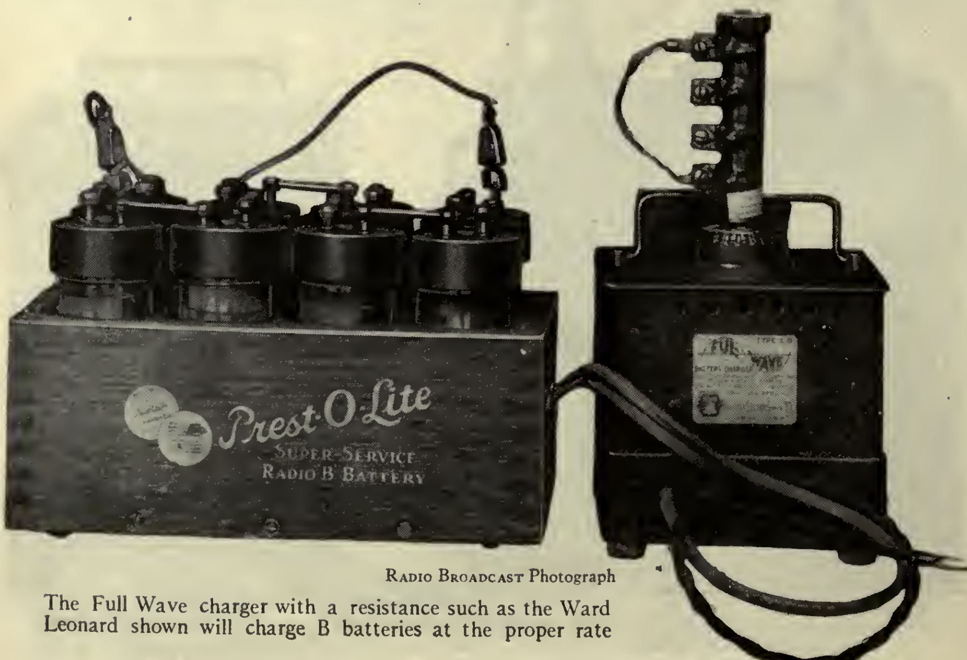


Radio Broadcast Photograph



Radio Broadcast Photograph

A B battery substitute that anybody may build up from Molliformer parts. Here are chemical rectifier jars, filters and a transformer.

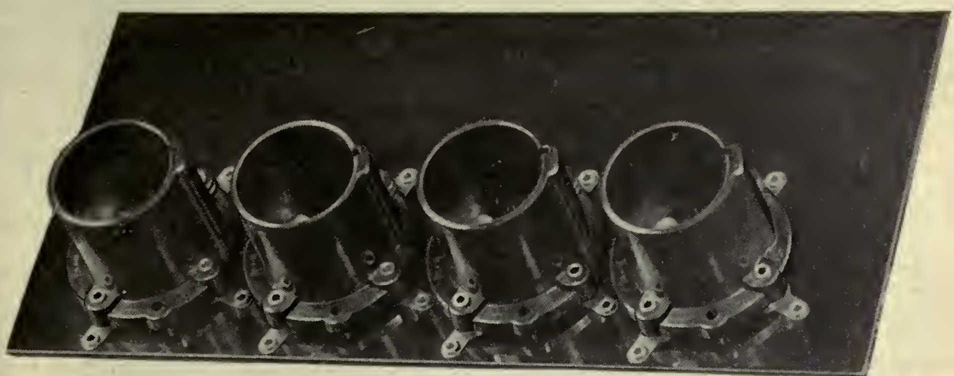


Radio Broadcast Photograph

The Full Wave charger with a resistance such as the Ward Leonard shown will charge B batteries at the proper rate

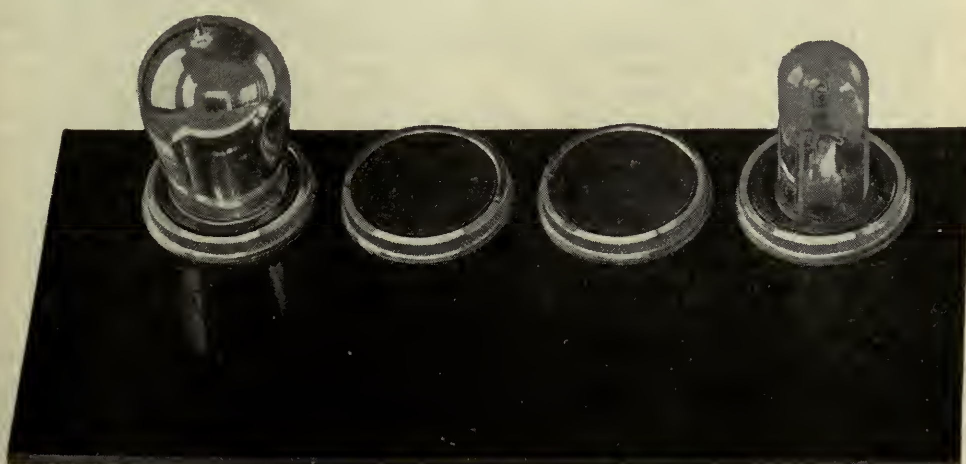
RADIO BROADCAST Photograph

Several interesting devices that have been sent to the Laboratory. They are variable high resistances, a pilot lamp, a lock filament switch and a ballast resistance designed to eliminate the need of rheostats



RADIO BROADCAST Photograph

Two views of a tube socket panel, the lower made by Burton & Rogers of Boston, the upper one by The Alden Mfg. Co., of Springfield, Mass. Both are designed for RADIO BROADCAST'S Phonograph Receiver



RADIO BROADCAST Photograph

them the lower will be the output voltage. That is a disadvantage and is due to the high resistance in the tube itself and in the filter. If a sufficiently high voltage is used at the start and if control resistances are included, this disadvantage may be partially overcome. There is one advantage in the high resistance feature since it is impossible to draw enough current from the device to blow up tubes, during accidental mix-ups in A and B battery leads.

Chemical B battery suppliers are generally low resistance affairs, and the output voltage is more independent of the output current load. The Balkite eliminator is an excellent example of this type of supply unit.

THE LIFE OF A TUBE TYPE ELIMINATOR

THE useful life of a tube operated eliminator depends entirely upon the life of the tube. In practice, the tube is used as a two-element rectifier and receiving tubes do not have sufficient electron emission to stand up under this kind of treatment. In the Laboratory, an average life of 200 hours has been obtained with receiving tubes with a five-tube set drawing about 25 mils. Some tubes lasted about 50 hours, others as long as 400 hours, but the average is too low. Special two-element tubes are now on the market for this service and samples have been sent to the Laboratory from Kellogg, Dubilier, Sea Gull, and Timmons. An average life of 600 hours may be expected from this newer type of tube.

Eliminators employing two tubes will last longer and deliver a better form of current—theoretically, at least. The component parts of such a set are well shown in the photograph of the Apco layout, and the "works" of a chemical supply unit may be seen in the Molliformer kit photograph.

Tube B battery substitutes have been sent to the Laboratory by the following manufacturers, Timmons, Kellogg, Mayo, Rhamstine, Dubilier, Apco, and Mu-Rad.

Several interesting tubes are shown in the accompanying photographs. They are the Rectron of Dubilier (used in the Super-Ducon) for B battery eliminator service, a Tungar for charging batteries, the McCullough tube whose filament runs from a. c., the S tube of the Amrad Corporation and the Neon Tube of the Neon Products Corporation. The latter two do not have filaments and operate upon the gaseous conduction principle. They may be used in either receiving or transmitting rectifiers, since 100 milliamperes may be taken from them safely.

The filters used in these various types of B battery suppliers are required to iron out the remaining hum which is due to the alternating current. If the filter has high enough inductance and enough condensers, the hum will not be noticeable on either loud speaker or head phones, and is a vital part of the instrument.

A step-down transformer is necessary for the McCullough tube, and two are illustrated in this article. One is made by Dongan and the other by the Radio Foundation. A special transformer which supplies low voltage for amplifier filaments and 350 volts for power amplifier plate is also illustrated.

In deciding to purchase a battery eliminator, the prospective owner should discover whether it will cost him more to run than batteries, if it will be more convenient, and if more convenient and more expensive whether it is worth it. An average five-tube set worked three or four hours a day will cost about $15 a year in B batteries, and an average B battery eliminator can be run ten hours for one cent, payable to the lighting company. Special tubes or the old type 201 tungsten filament tube should last at least 500 hours—and there you are.

PHONOGRAPH RECEIVER APPARATUS

A NUMBER of interesting gadgets have come to the Laboratory which have an application to the Phonograph Receiver. One of these is an A battery protector which automatically breaks that circuit when too much current is drawn. It is made by the Precise Corporation of Rochester who made circuit breakers for power companies before radio was literally on earth. It will protect a battery from accidental short circuit, or, when charging batteries from current surges.

Four-tube base panels are made by Benjamin Electric Company of Chicago, Alden of Springfield, and Burton & Rogers of Boston. The latter has the sockets set somewhat below the panel so that considerable space is saved. Views of these panels are shown.

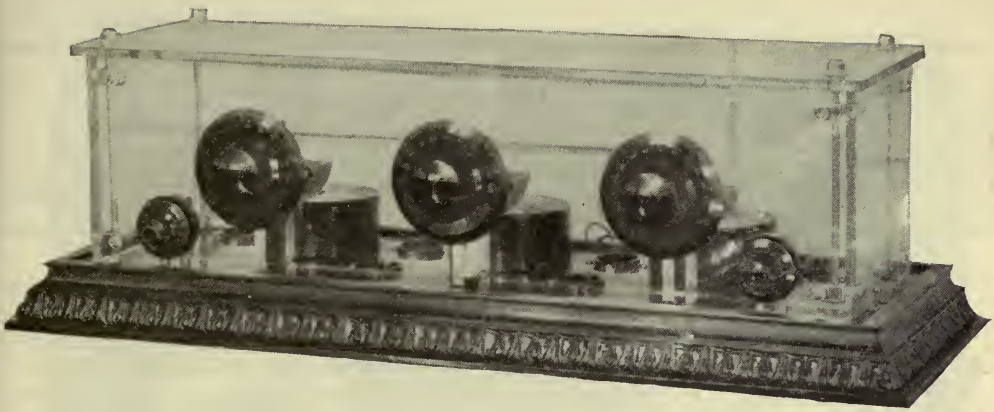
Pilot lamps to tell one when tubes are lighted are made by Yaxley, and Carter of Chicago. These small lamps are set behind the panel with a glass window through which they may be seen. They take about .1 ampere at five volts, and make an attractive and useful addition to any receiver.

Ballast resistances which will take the place of rheostats in filament control have been sent to the Laboratory by Daven and Amperite.

A useful and interesting lock switch has recently come to the Laboratory from Carter. This switch turns on or off the filaments and requires a key similar to that used in automobile locks.

Two volume controls have presented themselves, one known as a Clarostat and the other a graphite resistance of several ranges sold by Electrad, Inc. Both of these may be used as volume controls—as may the Bradleyohm—by placing them across audio-frequency transformers; for B battery eliminators and for any other purpose where a high variable resistance is needed.

A very useful place for such variable resistance is across a fixed tickler, to control regeneration in a detector circuit as in the Roberts circuit. The ease of control appeals to the operator of the receiver, and the fact that amplifier plate voltages may be placed on the detector eliminates the business of tapping a B battery.



Two receivers and a loud speaker are illustrated in these photographs. The receivers are the Clearfield and the Richardson "5" They are both of the tuned radio frequency type. The Superspeaker Console speaker comes from the Jewett Radio and Phonograph Co.

"NOW, I HAVE FOUND . . . . ."

A Department Where Readers Can Exchange Ideas and Suggestions of Value to the Radio Constructor and Operator

A FIFTEEN DOLLAR CW "LOW LOSSER"

MANY fans wish to know something about the shorter wave work, which is both c. w. (continuous wave) and phone. It is very much worth while to build a "low losser" for such work because the results obtained are noticeably superior.

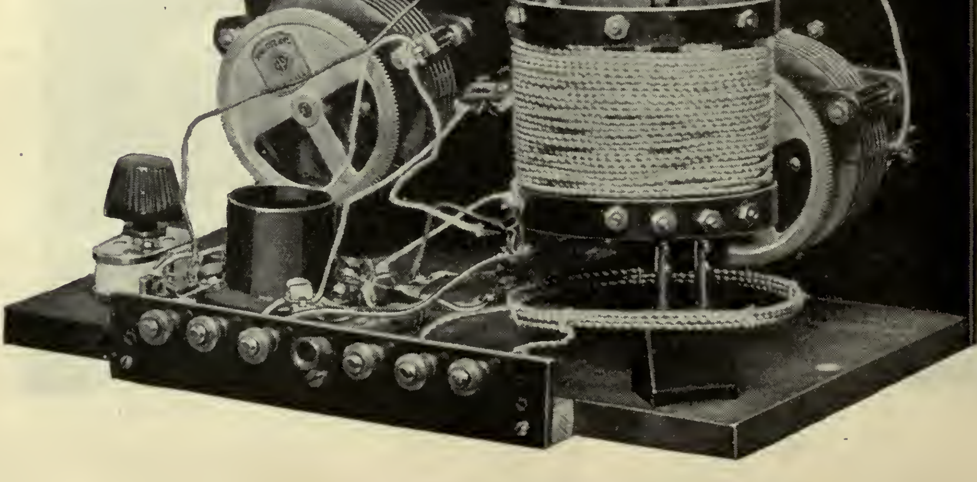
Low-loss, when stripped of all technicalities, simply means high efficiency. The big bugaboo of radio is resistance. So, any set which is built with the idea of reducing this will be a low-loss one and therefore of so much higher working efficiency. That being the case, make up your mind that the best is the cheapest in the long run and you will not spoil what otherwise is an excellent set. The total cost will not be over fifteen dollars, exclusive of tubes, batteries, and the head telephones.

The three circuits A, B, and C shown in Fig. 3, are all suitable for our purpose, but A has the disadvantage of being coupled too closely to the antenna and we may therefore disregard it. B and C are not open to this objection, as the antenna circuit is coupled inductively to the secondary and entirely separate from the rest of the set. The choice between these two lies only in the method of securing the feedback control. In B it is secured by the tickler coil method so well known to the exponents of the so-called "three coil tuner." In C it is obtained by a variable condenser. Take your choice.

Coil P need consist of but three turns of No. 18 "bell wire" $3\frac{1}{2}$ inches in diameter and bound or taped into circular form. Then mount it in any fashion so as to have it "stood up" a few inches from the grid lead of coil S. An easy way to do this is to support the free ends in two binding posts.

Coil S is constructed as follows: obtain two pieces of bakelite tubing each $3\frac{1}{2}$ inches in diameter and one half inch long. Obtain also six strips of bakelite each $\frac{1}{4}$ inch thick, $\frac{1}{4}$ inch wide and 3 inches long. Mark the

FIG. 1
Looking at the receiver from the rear



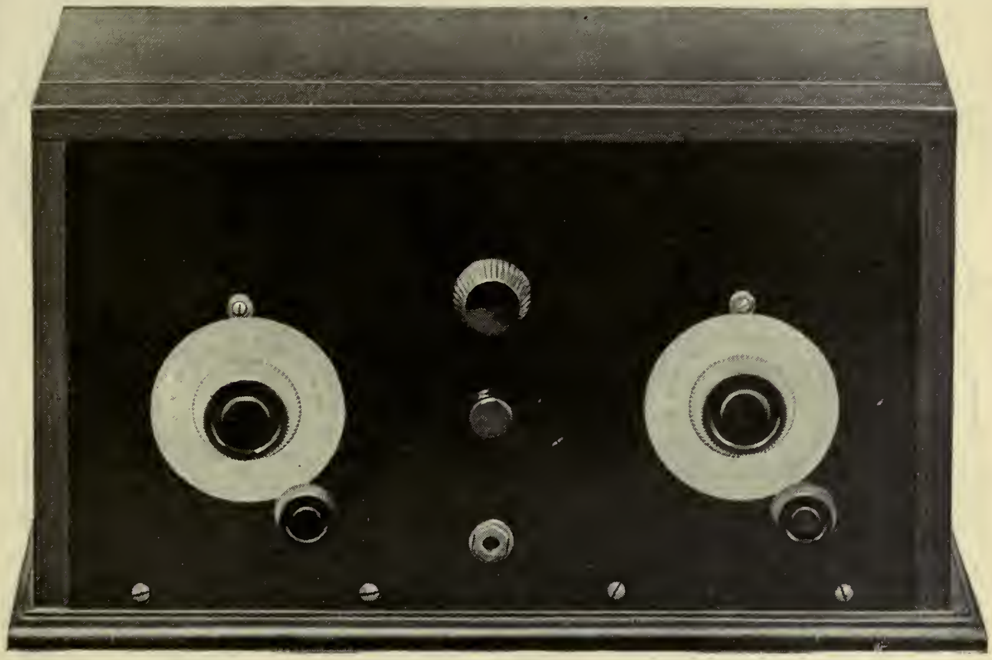


FIG. 2
A front, panel view of the receiver

periphery of each bakelite tube into six equally divided segments and drill a hole to take a 6-32 brass bolt at each point. Drill the ends of the strips with similar holes and you then have a nearly cylindrical form for winding, the ends of which are the two bakelite tube pieces and the sides of which are the strips. In case bakelite is not available dry wood may be used and the strips mounted with the aid of small wood screws. Be sure to have all wood thoroughly dry and to treat it with a light coat of melted paraffin to prevent moisture absorption.

Various methods of mounting this coil may be devised. The writer attached an old Paramount coil mount by means of two machine screws and used an ordinary Remler honeycomb coil mount as receiver for it. Two Remlers will do the same thing and such an idea enables coils to be easily shifted for different wavelength ranges. For the longer amateur waves, fifteen turns of No. 18 bell wire are used and ten turns for lower waves.

For the tickler coil "ball assemblies" may be made or purchased and first treated with a paraffin bath. Be sure to place your tickler at the filament lead of S to reduce its effect on tuning and remember to reverse its leads if regeneration is not first obtained. A small tickler of more turns has less disturbing effect on tuning than a larger one of fewer turns. The number of turns varies in different sets, but ten turns may serve as a trial.

A small radio frequency choke may be needed at Ch in C.

In using condenser feedback, merely wind coil S and continue the winding, adding about ten turns to comprise the feedback winding, having provided a twist tap for filament. The feedback condenser, here, may be of .00025 mfd.

A well made variable condenser is a positive necessity. It should have a small amount of insulation present, it should be mechanically rigid, and good electrical connection must be had between members. The capacity should be .00025 mfd. maximum.

A good socket and variable grid leak are to be included. Finally, be sure you have a real antenna and ground. A single wire is sufficient. No panel layout is given here because so many experimenters will wish to work out their own.

In operating the set, note that the distance of the coil P may be varied from S as an advantageous feature because smooth tuning may not be had otherwise due to a resonance effect in the antenna, causing a "blank" in the tuning dial.

Several novel features to be noted in this set:

1. Ease of coil changes.
2. Filament connections by plug and jack, allowing ease of change to another set.
3. Use of Fahnestock clips as the set is primarily an experimental one and changes may be easily made.
4. A low-loss coil that is mechanically strong and electrically efficient.
5. A set which is simple, efficient, and easy to operate.
6. A set which is very low in cost.

—C. S. Mundt, San Francisco, California.

TWO SHOP TRICKS

HERE'S an idea for a simple home made rig for cutting spiderweb coil forms, bezel holes in panels, or holes for the Ballantine vario-transformers. First drill a center hole with about a $\frac{3}{8}$-inch twist drill in the panel, then drill a hole in a piece of hard wood about $\frac{3}{8}$ x $\frac{3}{4}$ x 6 inches long. Remove the drill from the brace or hand drill and leave the drill in the piece of wood. Next take a small file and grind the end down as shown in the sketch, Fig. 4, and clamp the file to the piece of wood with two five-and-ten-cent-store clamps. Fit the drill in the center hole in the panel and go round and round and back and forth, holding the drill in the left hand and the stick in the right. A stick 6 inches long will give you plenty of leverage. Cut from both sides and the result is a clean cut hole and, best of all, it is round. I can cut spiderweb forms with this which have one tooth longer than the others for support and all are the same size and look like factory goods.

This is a suggestion for a three-plate vernier condenser built for about tweny cents, and looks well from the front of the panel. First get a panel switch with bushing and about five cents worth of common sheet zinc (same as used for flashing). Cut out a piece the size shown and solder it to the end of the switch shaft. After cutting out the other piece to the shape shown fasten it to the panel with screws and nuts or you can use switch points if you have them on hand. Connect this in parallel with the main variable condenser and you will get the surprise of your life. The rotor should be grounded. I made one of these the other day and found it better than the ordinary vernier condenser. See Fig. 5. Only the switch knob shows on the panel with the lever cut off.—Welsford A. West, Hopewell, Nova Scotia.

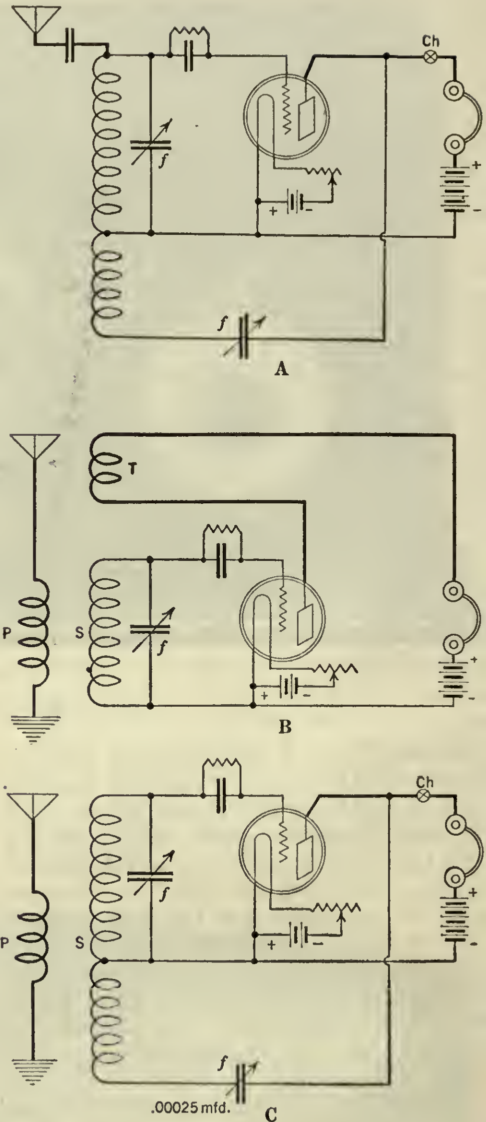


FIG. 3

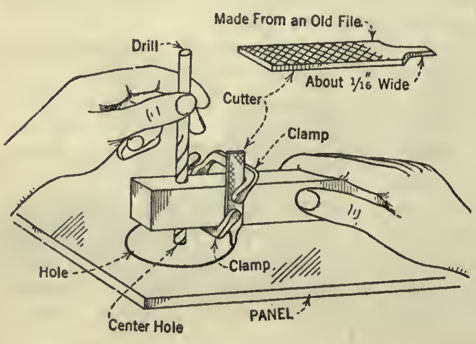


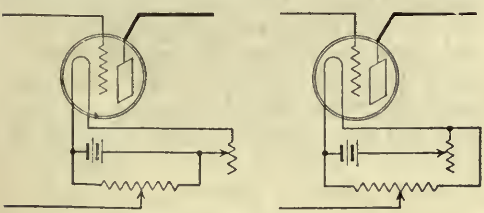
FIG. 4

AN AUTOMATIC POTENTIOMETER CUT-OUT

NOW that multitube radio sets are being used so extensively we have frequent recourse to potentiometers to stabilize the radio frequency circuits. In the usual hook-up for a potentiometer, Fig. 6 it is hooked up directly across the A battery terminals. This, of course, slowly uses up current and as sets employing r. f. consume plenty of current without the help of a continual leak, we frequently resort to some form of cut-out switch.

The usual ratings of potentiometers are 200 and 400 ohms. The loss across a 200–ohm one amounts to about 0.03 amperes day and night or nearly one half the current consumption of a UV-199 vacuum tube. The 400-ohm size has a current flow of 0.015 amperes, which in three or four weeks would run down a storage battery without the set being used at all.

The setting of a potentiometer does not affect this loss, as the entire resistance is connected across the battery and turning the dial to zero does not open the circuit, contrary to the belief of many people.



FIGS. 6 AND 7

Fig. 7 shows a hook-up that automatically cuts out the potentiometer when the filament rheostat of the first r. f. tube is turned off. The ohmage of the rheostat is added to that of the potentiometer, but that does not detract from its efficiency.—K. W. ROOT, Boston, Massachusetts.

A TOOL TO DRILL HOLES IN GLASS

TAKE an old three-cornered file and on an emery wheel, smooth down the face of all three sides, so that the edges are knife-like.

Then break off the point of the file, say about one inch from the bottom, and with the emery wheel bring all the sides to a point as in Fig. 8.

To drill holes in glass, mark your holes the same as on a bakelite panel but use a glass cutter to make the center mark. Make a

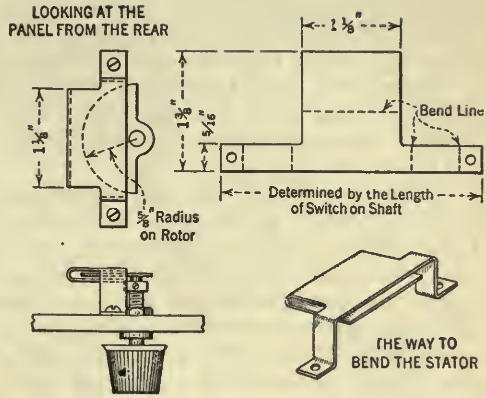


FIG. 5

small cross where you want the hole, then take the tool and put it in a brace. Put some turpentine in a small oil can and apply a little on the tool. Do not try to drill too fast as you are apt to break the glass, also do not press too hard on the drill. When almost through the glass, that is, when the point comes through the other side, turn the glass over and drill from that side. Do not cut too fast or chipping will occur.

Be sure to apply plenty of turpentine to the tool or it will not work satisfactorily. If it is desired to make the hole larger, use a file of greater size and ream out as with bakelite panels. Be sure the glass is on a level foundation.—C. J. EISEN, Watertown, South Dakota.

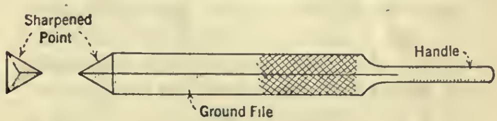


FIG. 8

SEVEN CONSTRUCTION IDEAS

TO START a screw in an inaccessible spot, an electrician sticks a bit of tape over the end of his screw driver, just thick enough to make a snug fit in the screw slot. In this way he can start the screw down a hole as deep as the screw driver itself.

The clock maker and watch maker use wooden screw drivers to handle their small screws. That is they sharpen a toothpick or wooden skewer to make a snug fit in the screw slot. You can start a nut in a hard place by lightly forcing it on the end of a hardwood stick, leaving one or two threads free.

Another trick is to wind a wire around the screw, to hold the screw where you want to

start it. The wooden-screw driver or the electrician's tape trick—paper will do in place of the tape—meet most emergencies, however.

Clockmakers, when they break off a steel screw in a brass plate, boil the plate in alum water. The alum attacks the steel, but not the brass.

Rubber panels, with all their advantages, have one defect which must be watched. Under constant pressure, rubber gives; and a nut, driven home tight, will gradually loosen. Go over your panel after a few weeks, and give all nuts an added turn with the socket wrench.

Wind the NP coil, of the Roberts set, on the same frame as its secondary, using No. 36, or finer, wire. Wind the NP on first, then the secondary on top of it. I think that the diamond-weave is best, giving a broader wave band and sharper tuning. Remove spokes of the winding form, and sew coil together with dental silk. Then a half-inch strip of bakelite, $\frac{1}{16}$ inch thick, slipped through the coil makes a firm support and provides space for terminals.

This use of fine wire primary is in line with recent developments, to cut down capacity between primary and secondary. Grebe used No. 40 wire in the Synchrophase; and Browning-Drake concentrates a fine winding in a narrow slot at one end of the secondary.

Wind a few turns too many on the secondary; then remove the excess, turn by turn, until the right hand dial tunes exactly like the left hand dial.

Space the tickler coil fully an inch from the face of the secondary. The better your set is designed, the fewer tickler turns will suffice. Start with 15, and remove them turn by turn, until it just spills over when fully advanced, on the high wave. In a lively set, with a detector tube that oscillates easily, 12 turns should be enough. Choose a good oscillator for your detector tube, and burn it as low as possible.

Why not adopt and familiarize the prefix "pico" for micromikes? Thus, instead of saying a "triple-O-five" condenser, for an instrument of 500 micro-micro-farads, let us say 500 picos, which is correct and simple, if we once get used to it. To be precise we should say pico-farads, but we could drop the farads, once we get used to the pico end of it. Thus our standard ratings would be in 1000, 500, 350, and 250 picos, for tuning condensers; and we would specify balancing condensers as from 5 to 10 to 50 picos. Also, to say a tuning condenser has a minimum of 15 picos would be much simpler to the average mind than to follow the present practise of saying .000015 mfd.—F. I. ANDERSON, New York.

MAKING A NEUTRALIZING CONDENSER

A NEUTRALIZING condenser can be made at home very easily and at the same time very cheaply. Get a piece of good dielectric about 3 inches long and drill a hole about $\frac{1}{2}$ inch from each end. Bend two pieces of sheet copper or brass as shown in Fig. 9. Fasten them to the base by means of binding posts. Obtain a threaded brass rod $2\frac{1}{2}$ inches long that will fit a nut taken from a dry cell.

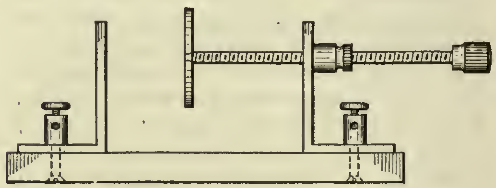


FIG. 9

Solder the nut to one of the bent pieces of copper or brass. Get a piece of copper about the size of a nickel and solder it to the brass rod, screw the rod into the nut and mount a small knob on the other end. You may neutralize your tubes by turning the knob back and forth, varying the space between the disc and the other copper angle.—CARL ROBERSON, Laurel, Montana.

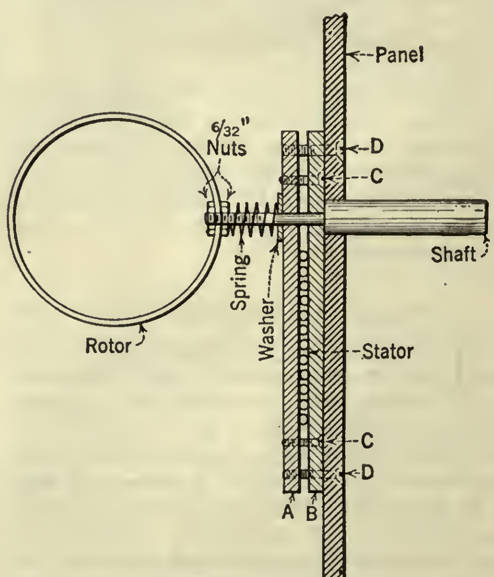


FIG. 10

A GOOD SINGLE BEARING FOR ROTOR COILS

THE bearing described here was first made for use with the self supporting low-loss coils recommended by Mr. Silver for his "Good Four-Tube Set."

The cross-section sketch, Fig. 10, shows pretty clearly just how the bearing mounts and works. A piece of regular $\frac{1}{4}$-inch brass rod is turned down on one end and threaded to the size of a 6-32 machine screw. Usually this end will be about $\frac{3}{4}$-inch long. The uncut end of the rod from the collar out is left standard length, about 1 inch long, to take a dial or pointer.

The two strips in the drawing are cut from some scrap 3-16 inch bakelite or similar material. The piece B may be about 3 by 4 inches instead of just a strip, as this will give the stator a more solid rest. It will also leave plenty of room for mounting binding posts where the various coil connections are made. The stator is firmly clamped between A and B by tapping holes and fastening with machine screws as shown at C-C, countersunk. This whole unit which now holds the stator coil is clamped to the back of the panel by the two machine screws at D-D.

Drill the panel to just clear the $\frac{1}{4}$-inch shaft. The collar will rest against the strip B just behind the panel. Now drill the strips A and B to just clear the turned parts of the shaft, the 6-32 end.

Place a brass washer over the shaft and rest against inside face of A. A small spring is placed over the shaft and held against the washer by a 6-32 hexagon brass nut. Place the rotor on the shaft and clamp in place with the second nut.

Tension on the bearing is adjusted by tightening or loosening the two brass nuts. This should be just enough to allow your rotor to stay where last turned without any undue binding. I find this a real economical bearing which solves low loss coil mounting troubles and is easily made from parts in your "scrap box."—GERALD GRAY, West New York, New Jersey.

A HANDY CRYSTAL DETECTOR

A BURNED out tube can be used in making a crystal detector that is easily substituted for the detector tube in single or multiple tube sets.

An old tube is held in a gas flame until the cement holding it loosens sufficiently to allow

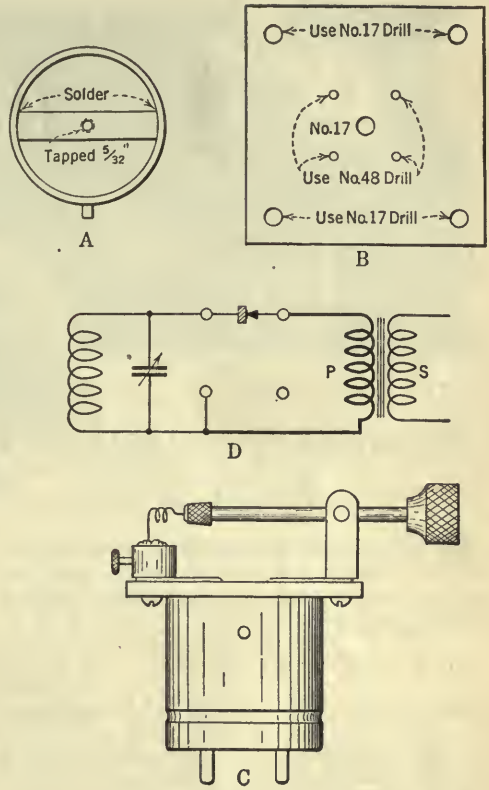


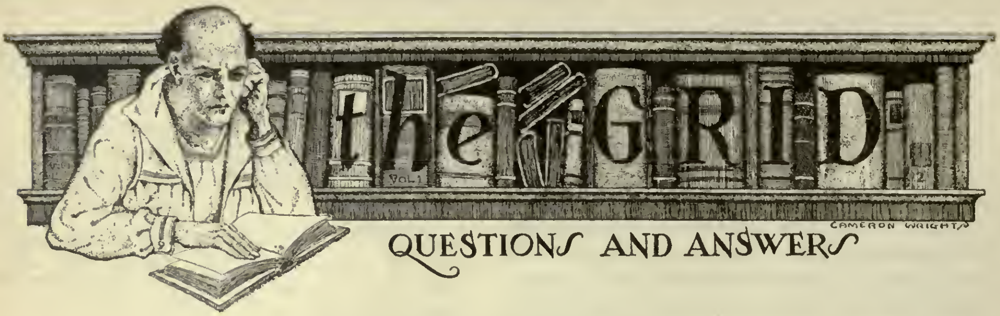
FIG. 11

the bulb to be drawn out of the base. A small piece of brass is soldered across the inside of the tube base, about 1-32 of an inch from the top. This is drilled and tapped for an 5-32 screw as in Fig. 11 A.

Cut a piece of bakelite or hard rubber about two inches square and drill as shown in B.

Solder four pieces of No. 18 bare copper wire 3 inches long in the prongs on the base, allowing them to project slightly. Slide the bakelite over the wires on top and put in the 5-32 screw in center. The wire is looped around machine screws in each corner. The crystal detector (which can, of course, be a fixed one) is connected from grid to plate, which is the same side as the pin is on. The other screws which connect to plus and minus filament have binding posts. See C in Fig. 11.

To use this device, remove the detector tube from its socket, short circuit the grid condenser, remove the detector plus B wire from the battery and connect it on the binding post of the crystal detector, but be sure to use the one which leads to your grid return as in D.—FRANK MEISTER, Jersey City, New Jersey.



QUERIES ANSWERED

May I have a circuit and explanation for the testing of vacuum tubes?
E. F. McC.—Chicago, Illinois.

How can I make a test for a good ground?
N. P. L.—Brooklyn, New York.

Is there some simple way for comparing loud speakers?
A. S.—Newark, New Jersey.

Will you publish a circuit for a simple crystal receiver?
M. O.—Patterson, New Jersey.

What is meant by "matching tubes?"
S. T. A.—Montreal, Canada.

Can the Roberts receiver be used with a loop?
L. A.—San Juan, Porto Rico.

What coil combination will replace the UV-1716 transformer in super-heterodynes?
V. St. M.—Baltimore, Maryland.

How may toroid coils be used in neutrodynes?
R. M. T.—Detroit, Michigan.

HOW TO TELL THE CONDITION OF VACUUM TUBES

HOW efficient are your vacuum tubes? A vacuum tube, to be satisfactory must be able to operate over a long period of time at maximum efficiency.

Merely inserting a tube in a socket and noting whether it lights does not constitute a practical test of the tube's efficiency. Above it was said that a tube should be at its maximum point of efficiency for a long period of time to be satisfactory but this is the only figuratively speaking. Under actual operating conditions the efficiency of a tube will fall off as its hours of use increase.

To determine the condition of a tube it is necessary to know several things such as input voltage, its filament voltage and amperage, plate voltage, and the current in milliamperes which is being consumed in the plate circuit. To know these facts a test circuit having meters for testing the various voltages and currents must be employed. Such a circuit is shown in Fig. 1.

Storage battery tubes are usually operated at 5 volts and at this potential the current consumption should not be over ¼ of an ampere for the 201-A type. Dry cell tubes are either of 3-volt or 1½-volt operating potential and draw not over .06 amperes for the former and .25 ampere is for the latter.

When tubes are new, the electronic emission which is indicated in plate milliamperes is naturally high when a normal plate voltage is applied, say 90 volts. As the tube grows older or if the filament is burned too brilliantly the plate mils decrease quite rapidly, materially affecting the property of the tube to function correctly and efficiently.

With the meter circuit described here it is possible to make graphs of the function of a tube at various grid or input voltages. By means of the variable resistance R1, the grid voltage may be varied from 10 volts negative to 10 volts positive.

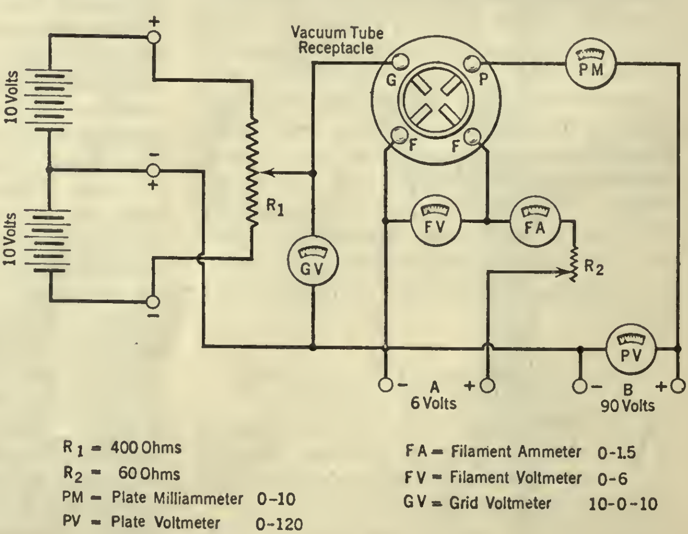
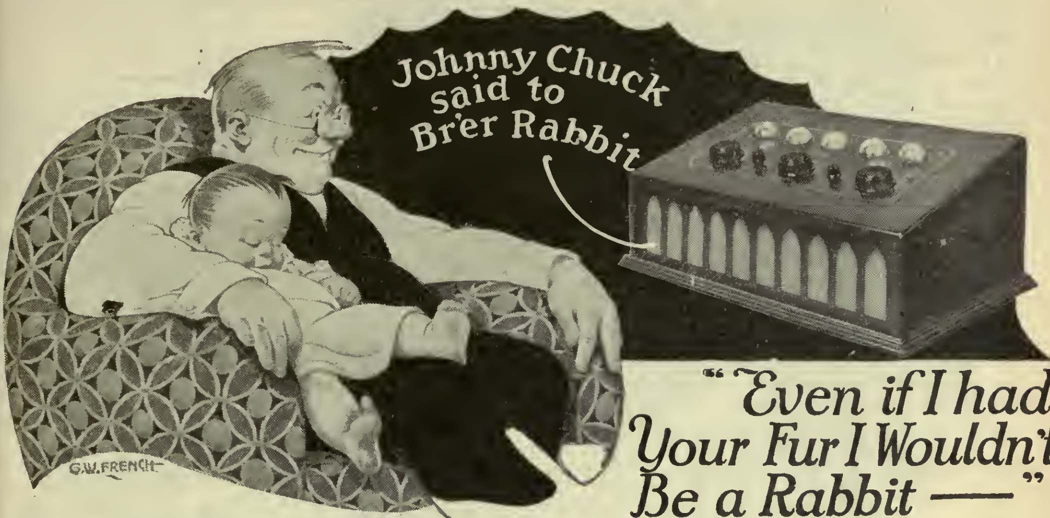


FIG. 1



"Even if I had Your Fur I Wouldn't Be a Rabbit —"

AN attractive cabinet can never make an Ozarka out of any other radio. Far too many radio buyers pay more attention to the outer appearance and not enough to the inside. The service behind the radio you buy is even more important than the inside or outside, your satisfaction depends on it. Let us see just what radio service is.

When your automobile runs as the manufacturer intended it should it is a real pleasure to drive it. But what do you do when something goes wrong? Do you immediately condemn the car?—no. Do you call in some handy man who can fix anything?—no.

You send for a service man who is trained in repairing your make of car. To correct the fault is easy for him because he knows. Some other mechanic might have to tear the car apart to locate the trouble.

The same is true of radio, no matter what price you pay—you will sometimes need the service of a service man. If he is factory trained and experienced he can and will deliver the kind of service you know you ought to have.

Ozarka instruments are only sold by direct factory representatives who are required to take a complete course of instructions in Ozarka serviçe directly under Ozarka engineers. By so doing we are assured that every purchaser of an Ozarka will have an experienced service man within reach at all times. 3100 such men today comprise the Ozarka service organization—more are being added daily. Ozarka service does not add a single cent to the price you pay for your radio—then why not benefit by it.

Ozarka instruments are sold only in competition side by side with others—do your own tuning and therefore decide for yourself just what Ozarka will do for selectivity, distance, volume and above all, tone.

Send for the book Ozarka Instruments No. 200; please give name of your county and we'll gladly have our Ozarka representative arrange a demonstration in your own home.

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RADIO offers a wonderful opportunity to men who wish to get into business for themselves. It is work that can be done, at the start, in the evenings and your spare time. You can hold your present position and learn radio under our plan. Ozarka instruments have been on the market for four years —they have successfully met all competition. Ozarka representatives have made good, not only because Ozarka Instruments are right but because our training in both selling and service is the most complete possible.

All we ask is that you are willing to purchase your demonstrating instrument and willing to learn what we are willing to teach you.

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Gentlemen: I am greatly interested in the FREE BOOK "The Ozarka Plan" whereby I can sell your instruments.

Name...

Address.......................City.............

County.....................State..............

★ Tested and approved by RADIO BROADCAST ★

At each value of grid volts a reading of plate current (in milliamperes) is obtained. Only the grid volts reading is varied. The plate voltage is fixed at a definite setting such as 90 volts. The filament circuit is adjusted to the correct filament voltage and amperage. Thereafter it is not varied for that particular tube.

With cross-section paper it is possible to make a curve of the operating characteristics of the tube. Along the left hand vertical edge of the paper may be indicated the plate milliampere readings, and the grid volts may be indicated along the bottom horizontal edge of the paper.

Starting at 10 volts negative grid, a reading of the plate current is taken and repeated for every two volts of grid input. This results in a series of points which gradually, then rapidly and then again gradually rise diagonally across the paper. After the readings are complete, the points may be joined together with a pencil or ink line producing a characteristic curve of the tube. See Fig. 2.

The more compact and vertical the curve is the better the tube functions as an amplifier. When the

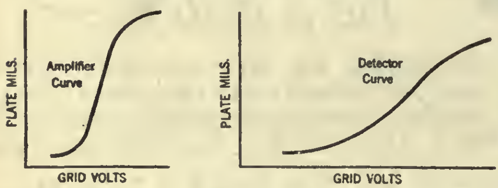


FIG. 2

lower or upper portion of the curve is spread out, the tube will operate very successfully as a detector. By means of this calibration method tubes may be compared and also selected for their various uses in a radio receiver.

A GOOD GROUND

THE problem of securing as near a perfect ground system for a receiver is one that should receive as much attention as the business of erecting a ship-shape antenna.

Cold water and radiator pipes are the usual grounding systems employed, but where the BX covering of light lines or in some instances the neutral line of a 3-wire light system is utilized it is well to make sure that they are actually grounded. To do this screw a 110-volt lamp into a socket to which has been attached two leads about two feet long. Use this arrangement as a test circuit by touching one of the leads on an object which previously has been quite definitely grounded. Now with the other free lead touch its end to first one side of the line, then the other and finally touch the middle line.

A circuit should occur on the two outside lines indicating that they are not grounded. However, for the middle line there will be no circuit inasmuch as it is the assumed grounded side of the 3-wire line. Under no circumstances should the lamp be shunted across both outside lines as the voltage there would be about 220 volts; blowing out the lamp.

Needless to say these tests should be made at the meter box where the 3-line system enters the house. Now while this test will indicate that the center line is not of a high potential in respect to the ground it is not a definite indication that it is

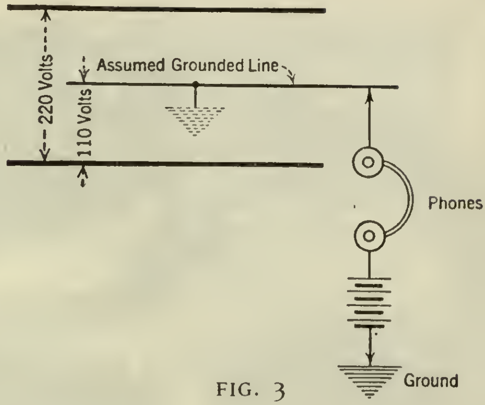


FIG. 3

grounded. Therefore, a circuit test should be made as shown in Fig. 3. A pair of phones and a B battery are all that is required. If a click occurs, the middle line is grounded.

HOW TO COMPARE LOUD SPEAKERS

RADIO dealers, experimenters and broadcast listeners are always interested to know whether or not their loud speaker is functioning satisfactorily.

Considering that a true test of a loud speaker would necessitate an elaborate outlay of precision test instruments it would seem that for those who wish to know how their own type of reproducer operates there is no suitable elementary method of attaining such ends. This is not entirely true where a comparison test will suffice.

Such a method is outlined and best understood by the circuit diagram in Fig. 4. A microphone button is attached to the pin lever of a phonograph tone arm. The primary of an audio frequency transformer is connected to the terminals of the button and the circuit is energized by a $4\frac{1}{2}$-volt battery. By means of a two-point switch which is connected to the secondary circuit of the transformer as shown, it is possible, when loud speakers are attached to the binding posts, to flip over from one to the other making comparisons on volume output, the quality, resonance points, etc.

The music or other audio signal is obtained by having a record revolving on a phonograph turntable.

A good audio-frequency transformer is an absolute requisite in this construction. One having plenty of iron in its core (which is of large size), large windings and also important one of low ratio

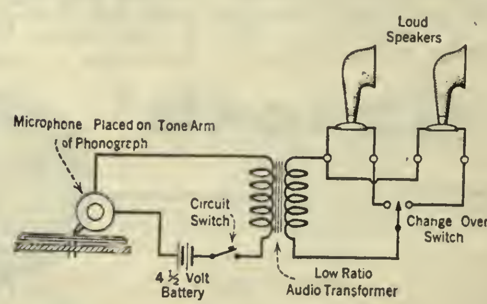
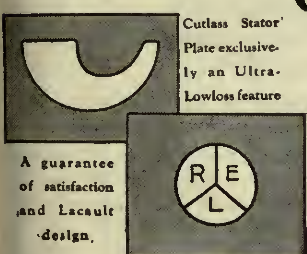


FIG. 4

Quick, positive tuning



Cutlass Stator Plate exclusively an Ultra-Lowloss feature

A guarantee of satisfaction and Lacault design.

SPEED—ability to turn directly to any station, to tune-in instantly and get your station without interference from broadcasting on similar wavelengths—is the outstanding feature of the Ultra-Lowloss Condenser.

With one station of known wavelength located on the dial, all others can be found instantly. Special design of Cutlass stator plates distributes stations evenly over the dial—each degree on a 100 degree dial represents approximately 3½ meters difference in wavelength.

In addition, losses common in other condensers are reduced in the Ultra-Lowloss to a minimum by use of only one small strip of insulation, by the small amount of high resistance metal in the field and frame, and by a special monoblock mounting of fixed and movable plates. Designed by R. E. Lacault, E.E., originator of the famous Ultradyne receiver and Ultra-Vernier tuning controls.

At your dealer's; otherwise send purchase price and you will be supplied postpaid

★

ULTRA-VERNIER
TUNING CONTROL

Simplifies radio tuning. Pencil record a station on the dial—thereafter, simply turn the finder to your pencil mark and you get that station instantly. Easy—quick to mount. Eliminates fumbling, guessing. A single vernier control, gear ratio 20 to 1. Furnished clockwise or anti-clockwise in gold or silver finish.

Silver, $2.50 **Gold, $3.50**

ULTRA-LOWLOSS
CONDENSER

PHENIX RADIO CORPORATION **116-C E. 25th St. New York**

★ Tested and approved by RADIO BROADCAST ★

is desired. The Rauland-Lyric and the General Radio 285 and 285A transformers are satisfactory for such purposes.

Such an arrangement offers an exceptional field for test and experiment not only of loud speakers but of microphone buttons and audio transformers which may or may not be suitable for such work.

A GOOD CRYSTAL RECEIVER

FOR a good crystal receiver circuit we are pleased to offer that indicated in Fig. 5.

The arrangement is simplicity itself. The parts cost is very low and such items as the coil and detector may be home-made. Winding A consists of 45 turns of No. 22 d. c. c. wire wound on a 3½ inch cardboard or bakelite tube. The ends of this winding are connected to the variable condenser terminals. This part of the circuit acts as a selector trap.

The winding B is wound for 10 turns directly on top of winding A. It is insulated from winding A by a strip of paper or cambric cloth. For purposes of experiment it may be advisable to have winding B wound with 20 turns of wire tapped every 5 turns.

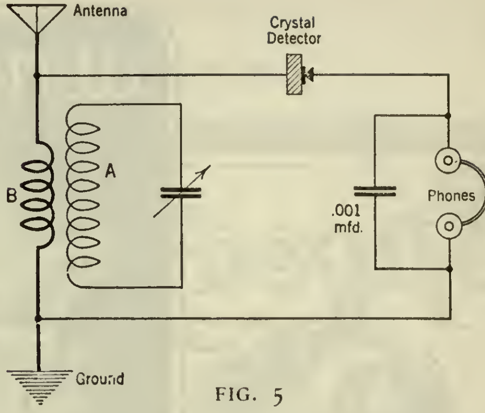


FIG. 5

A THREE-TUBE DOUBLE REFLEXED RECEIVER

MANY inquirers want data and a circuit diagram for a Roberts receiver which could be used with a loop.

In Radio Broadcast's Laboratory it has been found possible to operate an orthodox four-tube Roberts receiver on the antenna coil secondary without the aid of an antenna or ground. Naturally, too, a loop was successfully employed—but only for local stations. The first secondary coil was merely replaced by a loop as shown in Fig. 8.

If the reflex feature is taken out and a stage of straight audio substituted, much better quality of signals and sharpness of tuning will be observed.

For those experimentally inclined, the circuit diagram Fig. 6. should prove of unending interest. Here is shown a three-tube double reflexed receiver equal, in theory, to a standard five-tube set. Experiments have been conducted at Radio Broadcast's Laboratory and the set worked very well. But from a "how-to-make-it" standpoint it was felt to be of such little practical value that it was never especially described in the magazine.

Care should be taken in placing the coil units so that they are on the same plane and at right angles to each other. Bypass condensers are also important. For best results, the experimenter should try various values. Low ratio audio transformers have been found best for reflex work and especially so in all audio amplifiers where tone quality of the highest degree obtainable is desired. This data is advanced to our readers for what it's worth. It is not possible for us to furnish additional constructional notes for a completed layout. This data merely is to be regarded as of an experimental nature.

MAKING TRANSFORMERS FOR THE SUPER-HET

FOR about a year after the UV-1716 long wave radio-frequency transformers were put on the market, they acted as dust collectors and paper weights in many retail establishments throughout this country. Many of the radio jobbers found it difficult to explain to these dealers why

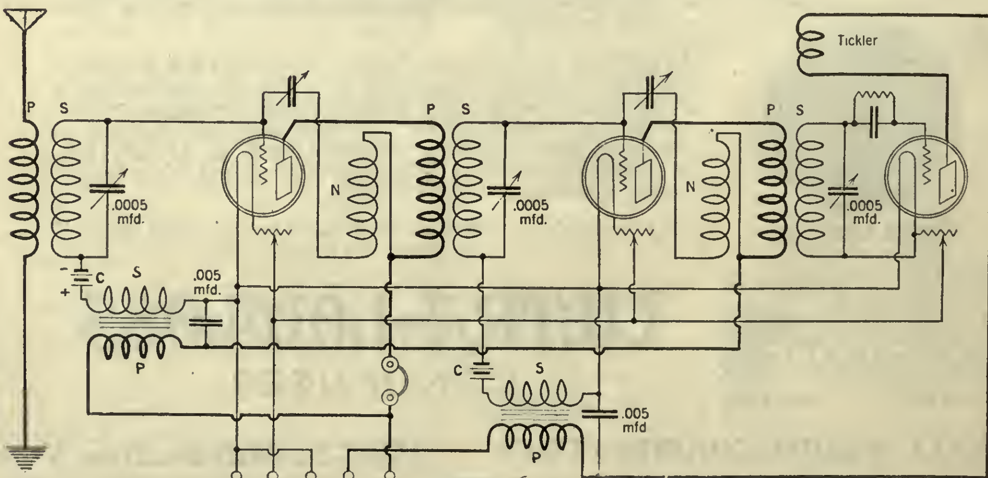


FIG. 6

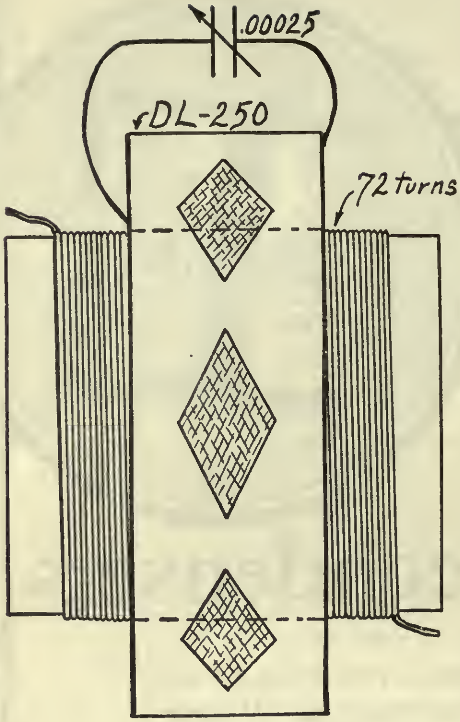


FIG. 7

so many of these transformers had been unloaded on them by glib salesmen. "Who," they would ask, "wants to use five thousand meter transformers when all the broadcasting is being done on less than six *hundred* meters?"

George J. Eltz, Jr., who is manager of the Radio Department for the Manhattan Electrical Supply Company, found this question extremely embarrassing. By developing a super-heterodyne in which these transformers would be used, he helped unload the shelves of every retail store in the country.

Today there are many types, shapes and sizes of intermediate transformers, but for those who wish to make their own, the data presented here will be of interest and value.

One of the simplest substitutes for this transformer, when used at its most efficient point—about 47,000 cycles—may be made as follows:

Procure a DL-250 coil and a piece of mailing tube just large enough to pass through it readily. On the mailing tube wind 72 turns of No. 32 double cotton-covered wire. These 72 turns form the primary. The DL-250 coil is shunted by a .00025 mfd. variable condenser. See Fig. 7. The current in the primary from the plate should flow in the reverse of that entering the secondary from the grid.

In the development of the super-heterodyne, several designers deemed it expedient to get away from the long wave transformers designed to cover a wide band of frequencies in favor of another type for which certain advantages are claimed. This latter type requires no iron in its core nor does it require tuning. Its fundamental frequency is comparatively high, and it will not permit audio-frequency disturbances to pass through the radio stages.

A wooden spool $2\frac{1}{2}$ inches in diameter with two slots 3-16 inch wide separated by $\frac{1}{8}$ inch and with a base diameter of $\frac{3}{4}$ inch is the winding form used for the windings. In the interstage transformers the primaries are wound with 800 turns of No. 32 d.s. c. wire, and the secondaries with 1000 turns of the same wire. The input transformer differs only in having its primary winding reduced to 300 turns so that with the .0005 mfd. condenser across this winding it resonates at approximately 99.9 K. C. (3000 meters).

The outside primary lead is run to the plate, the outside secondary to the grid. The inside primary goes to the B battery and the inside secondary to the stabilizer arm. The input transformer is used to feed from the first detector into the first r. f. tube.

TOROIDS FOR NEUTRODYNES

ONE of the latest improvements in radio apparatus, the low loss toroid coil, can be used in any of the neutrodyne and tuned radio frequency receivers to increase selectivity in tuning through local stations, and to stabilize the circuit. Its use in place of the customary aperiodic coupler used for tuning the first stage will improve the average receiver.

The interference, noise, and general tuning quali-

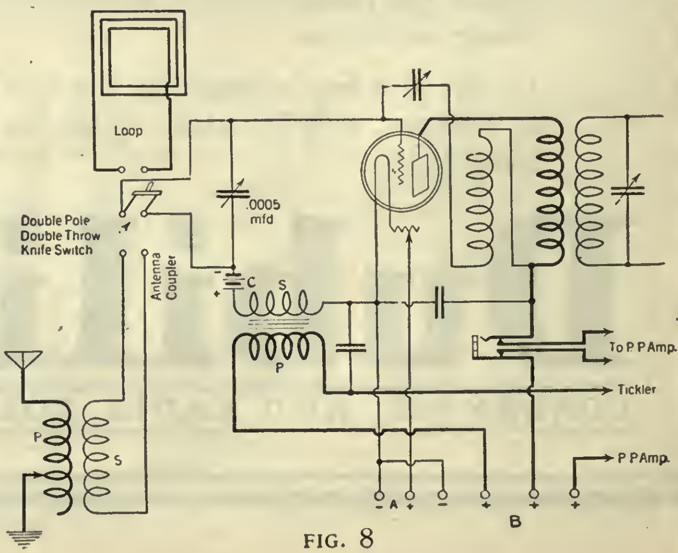


FIG. 8

Build this phenomenal new radio *in 45 minutes*

★

The revolutionary Erla Circloid-Five Factory-Bilt Kit—as you receive it.

Price $49.50

This new type kit is factory assembled. Ready cut, flexible, solderless leads make it ridiculously easy to wire. Amazing new inductance principle brings results hardly thought possible. Send for book, *Better Radio Reception.*

NOW anyone can build the finest of receivers in only a few minutes. No more wire bending or soldering. Merely attach a few ready cut, flexible eyeletted leads and the job is done. The finished set is unsurpassed even by the costliest factory-built receiver.

But most amazing is the new inductance principle incorporated in this last word in kits—called the Erla Circloid principle of amplification.

Four vital improvements result from this great discovery, which are not found in ordinary sets.

1. *Greater Distance:* Erla *Balloon *Circloids have no external field, consequently do not affect adjacent coils or wiring circuits. This enables concentration of proportionately higher amplification in each stage, with materially increased sensitivity and range.

2. *More Volume:* Increased radio frequency amplification made possible by Erla Balloon Circloids gives concert volume to distant signals inaudible with receivers of conventional type.

3. *Increased Selectivity:* Erla Balloon Circloids have no pick-up quality of their own. Hence only signals flowing in the antenna circuit are amplified. Static is greatly reduced for this reason.

Dealers: Exclusive franchises are available to high class dealers in localities still open. Write or wire immediately.

4. *Improved Tone Quality:* The self-inclosed field of Erla Balloon Circloids eliminates stray feedbacks between coils and consequently does away with mushing of signals and distortion. Tone is crystal clear and perfectly lifelike.

Write for free information on kit—also book. See how 45 minutes of fun will give you the newest and most nearly perfected set known to radio science. Easy as A-B-C to finish. Examine it at any Erla dealers, or send the coupon for full information, illustrations and diagrams *free*. Also ask for remarkable new book, "Better Radio Reception," describing the sensational new Circloid principle. Enclose 10c for mailing and postage on book.

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ties of the first stage are amplified and eventually become the output of the receiver. If the first stage is broad in tuning, the receiver will very likely lack selectivity. The action of the first stage has a great deal to do with the ultimate performance of the receiver.

The usual type of transformer used has a single layer-wound coil on a tube, with a tap taken off for the antenna connection. The field of the magnetic lines of force around the ends of the coil, created by the flow of current through the wire, spreads out and sprays near-by pieces of apparatus, causing distortion and making the receiver unstable in operation.

The toroid type of coil, on the other hand, has an entirely self contained field that prevents magnetic spraying effects. The low loss feature of one of the manufactured type of coil now obtainable is due to the fact that the wires are indented at every other face around the coil, thereby lowering the distributed capacity and resistance losses below that of ordinary coils to a noticeable degree.

To incorporate the coil in a regular neutrodyne or tuned radio frequency receiver, all that is necessary is to remove the present coil used for tuning the antenna circuit and replace it with a toroid coupler. The same condenser can be used to tune the receiver providing it is of .0005 mfd. capacity.

To construct the complete receiver as shown in the diagram Fig. 9, the following list of apparatus will be needed:

1—toroid coupler.
2—radio frequency transformers, tuned type. (Radio Frequency transformers of the toroid type may be used here with excellent results).
3—.0005 mfd. variable condensers, preferably straight-line frequency low loss condensers so that the lower wavelength stations will be separated far apart enough to make tuning easy.
5—standard vacuum tube sockets and five rheostats, 25-ohm for the 6-volt and 40-ohm for the 3-volt type tubes.
2—low ratio audio frequency transformers, 3 to 1 ratio.
1—.00025 mfd. fixed grid condenser; 2-megohm grid leak; single circuit phone jack, binding posts, wire, a 7 x 24 or 26-inch panel, and a 7 x 23-inch baseboard will complete the list of apparatus necessary.

Follow out the wiring diagram Fig. 9 in building the receiver, spacing the regular tuned radio frequency transformers at least six and one half inches apart. If toroid transformers are used, as well as the coupler, then the spacing can suit the arrangement of the rest of the apparatus in your set, without fear of interstage coupling.

ON MATCHING AND UNMATCHING TUBES

WITH the general consistency of the better vacuum tubes being sold to-day there is small necessity for "matching tubes." The fact is, for most purposes tubes are so similar in their characteristics that they may be considered as being matched. The notable exception is in the super-heterodyne, where juggling tubes around in the intermediate stages is usually necessary to secure satisfactory reception. But contrary to the general idea, this changing of tubes does not necessarily constitute matching. It is often a process of deliberate unmatching, which in many cases stabilizes the action of the amplifier.

Satisfactory reception on the "super" can seldom be achieved other than by use of the highest grade tubes. Some bulbs, which function in other receivers in this laboratory show up their defects in "super" operation. Howling, instability (uncontrollable oscillations with beat whistles) at normal plate voltages are evidence of poor or improperly balanced tubes in the intermediate amplifier.

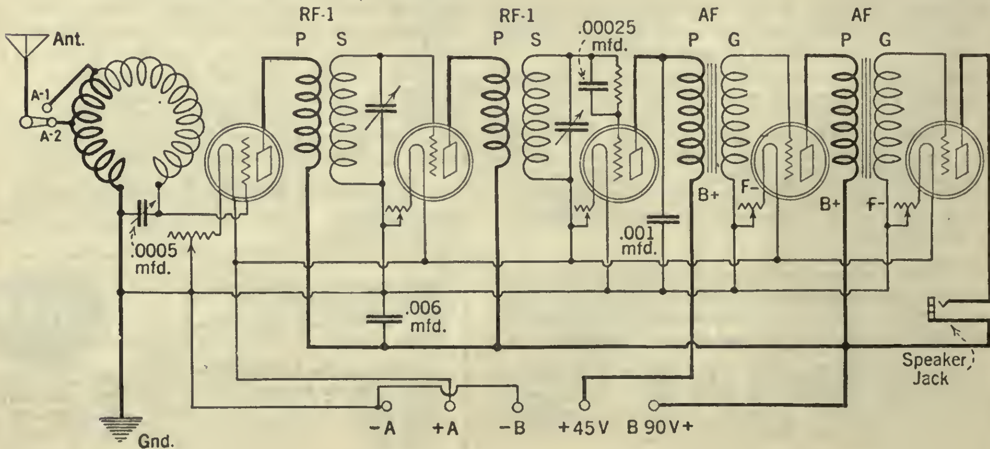

FIG. 9

It's a *genuine* UV-201-A only when it bears the name Radiotron *and* the RCA mark

WD-11, WD-12, UV-199, UV-200, and UV-201-A are the type names of Radiotrons. They belong to Radiotrons only. To be sure you are buying the genuine, look for the name Radiotron and the RCA mark on the base. Then you are sure of quality.

Radio Corporation of America
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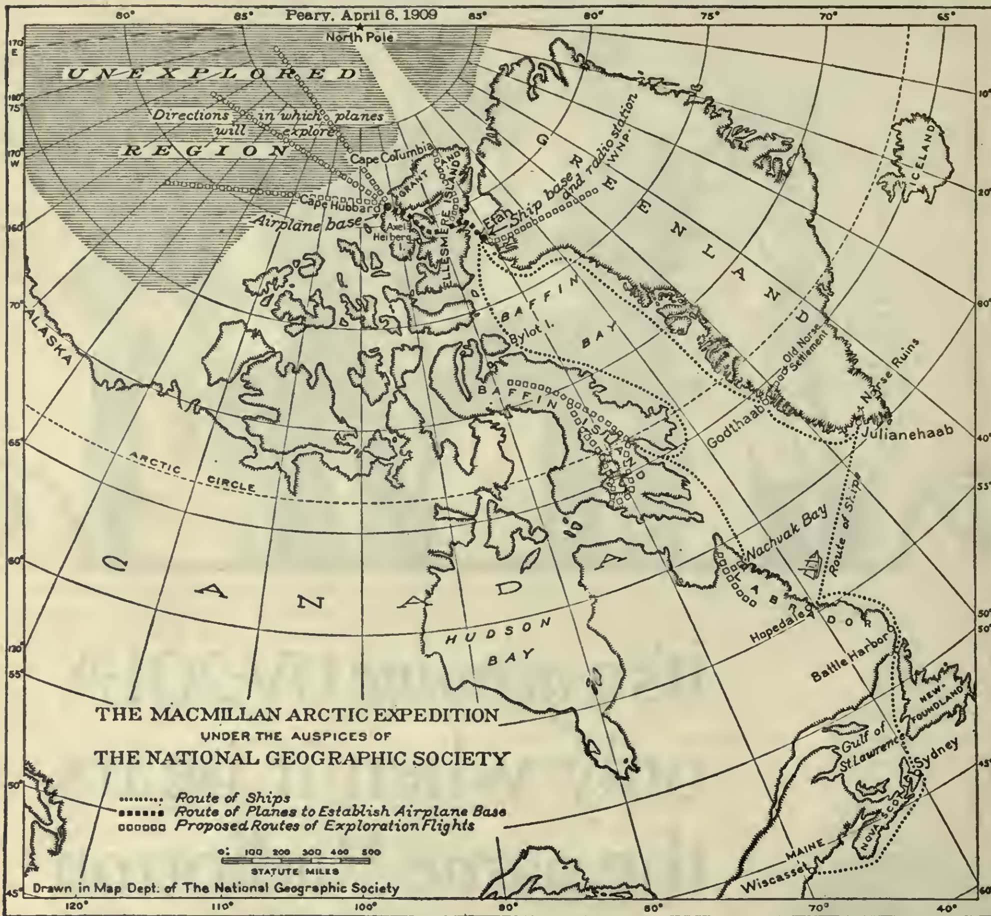
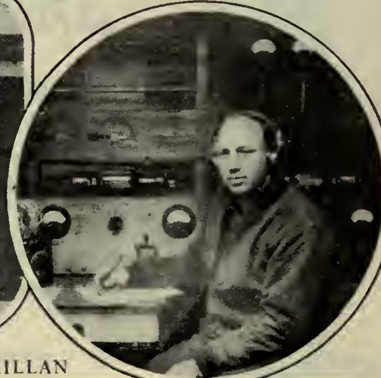




THE ROUTE OF THE MACMILLAN ARCTIC EXPEDITION

At present in Arctic waters. The map shows the route of the two ships, the *Peary* and the *Bowdoin*. The cut at the upper left shows the command of the expedition in the pilot house of the *Peary*. At the left is Lieut. Commander E. F. McDonald, Jr. (U. S. N. R. F.), in command of the *Peary*, next is Captain George Steele of the *Peary*, and at the right is Commander Donald Macmillan, in charge of the expedition. The insert at the right shows John L. Reinartz, radio operator in his cabin aboard the *Bowdoin*. Radio communication with the 40- and 20-meter transmitters aboard both ships has been established with amateur operators in the United States, Canada, and England from the Greenland base. Short waves are used because they are less subject to attenuation in daylight. The expedition during its entire time in northern latitudes will be in constant daylight. 2 GY, the short wave station maintained by RADIO BROADCAST has been in communication with the *Peary*, WAP, using a wavelength of 40 meters at her Etah, Greenland base

RADIO BROADCAST

Vol. 7 No. 6 October, 1925

And Now—The Radio Lighthouse

The Navy and the Lighthouse Service Have Joined Hands to Make Going Down to the Sea in Ships Increasingly Safer—How Ships Make Port, Guided by Invisible Radio Stations

By JAMES C. YOUNG

IN ALL the drama of radio, nothing equals that stirring call for help which sometimes comes from the sea. Since the first sos flashed word of peril afloat, the imagination of mankind has responded. Many a follower of the nightly programs, seated quietly at home beside his own comfortable hearth, has heard this sudden, vivid call, when the voice of every station is hushed as a tense audience awaits word of what goes on upon the far reaches of the deep. Surely no other experience quite compares with this waiting for the next message from a stricken ship, the message that may report her sinking with all hands, or convey the cheering news that another ship is standing by.

Radio has developed rapidly, and now hardly a passenger vessel remains on the high seas without its protection. From the moment that a ship leaves Europe until she ties up at her pier in New York, the long arm of radio guards the passengers aboard. Throughout the voyage it makes possible accurate reports on weather conditions, the movement of icebergs and ships, and any chance developments that fortune may bring.

AMBROSE CHANNEL LIGHTSHIP

Stationed outside New York harbor. Within the past year, radio equipment has been added to the other devices aboard this ship, which mark another step in the constant march of progress in making life safer at sea. The light at the masthead, the outside and the submarine bells, and the radio, all do their share to make the task of the navigator an easy one. During thick weather, day and night, a radio transmitter aboard this vessel sends out radio beacon signals on 299 kc. (1000 meters). The Government has installed similar transmitters on many important lightships on the Atlantic and Pacific coasts and on the Great Lakes

In the open sea there is relatively little danger to a ship, unless she encounters weather of the worst sort, but on approaching the coast her safety diminishes. There are other ships on all sides, reefs ahead, and a thousand possibilities bound up in fog and storm. This is the point where the lighthouse service of the United States takes charge of the ship's destiny.

This service, estab-

ROBERT GRAEME

Radio operator aboard the *Ambrose*. The radio equipment of this important light vessel serves probably a greater number of ships, totalling a larger tonnage, than similar equipment near any port in the world

lished in Colonial times, is the oldest branch of the Federal Government, antedating even the army and navy. And no government service has a finer record of brave deeds and high loyalty. During two hundred years of operation it has lighted the way of countless men and ships through dark waters. Boston Light, the oldest in the country, was destroyed by Indians when first built, and the Sandy Hook lighthouse, erected in 1764, was considered a particularly dangerous point. Redskins were all around and they showed small friendliness for lighthouses.

These ancient beacons of the sea have served to guide all kinds of ships. First came the high-prowed English frigates with ornamented forecastles, and brass cannon gleaming in the sun; stately Spanish galleons, prowling down the coast ready to seize any unprotected settlement; and graceful French corvettes, sails billowed in the wind. Then came our clipper ships to hang up records in the seven seas, the fastest things afloat.

The steadfast lights also guided the whaling ships, now almost a lost race of the sea, that brought home wealth in oil and bone for their New England skippers. They pointed the way for slave ships, the scourge of the seas. And who knows but Captain Charles Gibbs, the dread pirate who roamed the Long Island shore, set his compass by the Sandy Hook light?

But gone now are the frigates and the galleons; slave ships and pirates have fled the seas, and in their stead we have ocean liners and submarines. And though the lighthouse service still goes on, time has wrought great changes in it.

A new feature of the service is the lightships, which lie along the coast year in and year out in positions which ships can determine within a few feet. Every ship from Europe lays a direct course for Ambrose Lightship, anchored fifteen miles off the port of New York, and thus acting as the outpost of the harbor.

RADIO SIGNPOSTS FOR NAVIGATORS

IF THE weather is bad on nearing the coast the master of an incoming vessel is anxious to know if he is steering a correct course. He may also have doubt about his position at sea. Of course, every ship keeps a daily log of speed and progress, by means of which her navigator can, theoretically, determine his position at any time. But navigators, log books, and theories have a way of working at variance. Therefore, if the weather is thick and the coast not many miles away, the captain will look to the lighthouse service for help. Now, it might seem to any one not versed in nautical matters that the captain should be able to learn with little trouble just where his ship rides through the night and fog. But it is really a complicated problem. The captain will listen by radio for an automatic

CAPTAIN AUGUST LANGE

Of the Lightship *Ambrose*, a familiar "watermark" to all marine travelers in and out of New York harbor. Captain Lange says that broadcast programs do yeoman service in breaking the solitude of months of sea duty

signal sent out from several points off the Atlantic coast. These signals are transmitted as a part of the radio compass service, which joins vessels at sea with the lightships anchored near to shore. In the case of the Ambrose Lightship, her transmitter sends forth an automatic signal which continues for sixty-five seconds and is then silent twenty-five seconds, a sequence maintained as long as the weather continues bad. A similar signal also will be sent out from Fire Island lightship and another from the ship at Five Fathoms, near Cape May, New Jersey.

The captain who is trying to get his bearings has on board a receiving apparatus which makes these signals audible. This apparatus is operated by means of a dial placed in the center of a circle on which appear the 360 numbered degrees of the compass. In order to take the position of the Fire Island lightship the operator on the incoming vessel turns the dial of his radio compass to the point where the Fire Island signal becomes the faintest. If we assume that this point is on the right hand, or landward side of the ship, the master then knows that he has Fire Island at just about the point desired. But this signal alone will not provide him with an accurate bearing. In order definitely to determine his position, he must take what is known as a three-point bearing. And the lighthouse service once more is the means of assistance. Again turning the compass dial, another point is found where the Ambrose signal sounds the faintest. This should be somewhere directly ahead. Then the operator endeavors to locate the ship at Five Fathoms, once more turning his dial until the automatic signal from that point is fainter than anywhere else on the compass. In a general way the Fire Island signal represents East, the Ambrose signal stands for West and that of Five Fathoms for South. When the three lightships are thus linked with the incoming vessel her captain draws a line on his chart from each one to a point of latitude and longitude where the three lines meet. That point represents the position of his ship. This is a highly scientific and extremely accurate method of navigation, so that the master can be sure he is on the right course, and where his ship speeds through the night.

"FINDING" SHIPS AT SEA

IN BAD weather the radio compass service would be put into operation without request, but it is also possible for the master of a ship nearing New York—and this is true in many other American ports where the Navy has installed compass stations—to get his bearings in another way, namely, by making use of station NAH. This is the navy plant on Fire Island and has no connection with the lightship at sea. A master using this second method would flash a message of inquiry to NAH (probably the international

A TYPICAL DERELICT

Awash and abandoned. Government radio services are doing much, through the radio beacons and radio compass service furnished at many important United States ports, to prevent wrecks. In addition, warnings of these menaces to navigation are broadcast to ships through the agency of the Coast Guard. Last year, notice of 75 such partially submerged wrecks was broadcast by radio telegraphy

signal QTE, "What is my bearing?") to which the navy station would answer, QRX "Stand by." Then the radio operator at sea would begin sending a conventional signal, usually the letter "m," repeated many times, followed by his own call. While this message was in the air, NAH would call the lighthouse shore stations at Sandy Hook and Manasquan, New Jersey, by land lines, asking them to take the call of the ship and send back the results. NAH could then figure a three-point bearing for the vessel by a reverse of the process used by the master when determining his bearings by means of the lightship. Once determined, this bearing would be flashed to the vessel and she could lay her course accordingly.

The radio compass represents the greatest advance in navigation since man first invented the compass itself. Before the introduction of this new aid to navigation some few years ago, ships were steered in much the same manner as they had been centuries ago. From the beginning of man's adventure upon the water, he depended in large measure upon the old and honored lead for his enlightenment about shoals and his general position. Within the last century almost every coast in the world has been extensively charted. Each navigator has a map which shows the approximate depth of water along any coast that he may be sailing. By means of the lead line, thrown overboard at frequent intervals, it is possible to keep a check on the progress of the ship and determine whether or not she is getting into dangerous water. But a lead line at night, in a fog or heavy weather is sometimes deceptive and difficult to operate. Yet it was the only indicator approaching reliability that could be used by navigators of large and small steamships alike until the advent of the radio compass made it possible to obtain land bearings even when still at sea or in bad weather. The benefit of this invention to shipping the world around surpasses all estimates. It has brought a new measure of science into the always hazardous enterprise of steering a ship safely into port.

The Ambrose lightship is a dangerous station. Captain August Lange, her master, remembers more than one vessel which loomed up out of the night and fog and almost ran her down. At least one of these troublesome visitors struck the lightship head on, because the man at her wheel was headed directly for the exact spot where the lightship rides at her chain. But such incidents are fortunately not common, owing to various devices used by the lightship for self-protection. One of these is a submarine bell, dangling over her side, which sends out warnings at intervals. This bell has a deep, ominous tone. Each clang of its brazen tongue resounds underneath the surface of the water and is caught up by means of a receiving instrument on the bow of the approaching ship. Before the coming of the radio compass, the submarine bell was looked upon as a great advance in the science of navigation. Although the bell has a distinct value, it by no means compares with the method of communication from ship to shore.

Another means of warning the advancing vessel is the dependable steam whistle mounted alongside her single stack. In foggy weather this whistle blows loud and long, a mournful, warning blast, that can be heard miles away. The whistle is also regulated automatically and experienced mariners lend sharp ear on approaching the coast for this sturdy friend.

The last defense of the lightship, for her own protection and for that of all who travel the sea, is the two winking lights at her mastheads, burning brightly all the year round. In clear weather they can be seen for miles, the first signal of home that greets the returning sojourner from foreign lands. They have been the object of anxious regard for many an eye long denied the sight of home. Every soldier who went to France looked back to the Ambrose lightship as the goal of his hopes.

Once past this first beacon of the harbor, the navigator will usually turn his ship toward shore and steer for the sea buoy, three miles nearer land. This buoy has a winking gas light of its own, a whistle operated by the motion of the sea, and a submarine bell. From the buoy it is two and a quarter miles to the entrance of Ambrose channel, the highway of New York harbor, through which must pass the greatest volume of shipping known to any port.

Ambrose Channel has a spread of 2000 feet. It takes a nice eye to strike the middle of that channel at night, but many ships pass in and out, under the hand of pilots picked up from the pilot boat at the mouth of the channel. Along both sides of the way a string of buoys keeps guard over the course. Those upon the right are called nuns of the sea because of their red cones, like the headdress of religious women in the Middle Ages. The buoys upon the left are black cans with white lights. The Channel runs at an angle toward the coast of Staten Island and the man at the

wheel is guided by the West Bank Light, with the Staten Island Light further off. These are known as ranges, and by keeping his ship's head directly on the ranges, a pilot reaches the point in the Channel where he must put over his wheel and turn in toward the Narrows. If it is night he drops anchor at Quarantine and waits for the doctors to come aboard the next morning. Some hours later he will carry his charge up the bay, under the glory of the morning sun, to her dock. And thus with the aid of the lighthouse service ships come safely in from the sea.

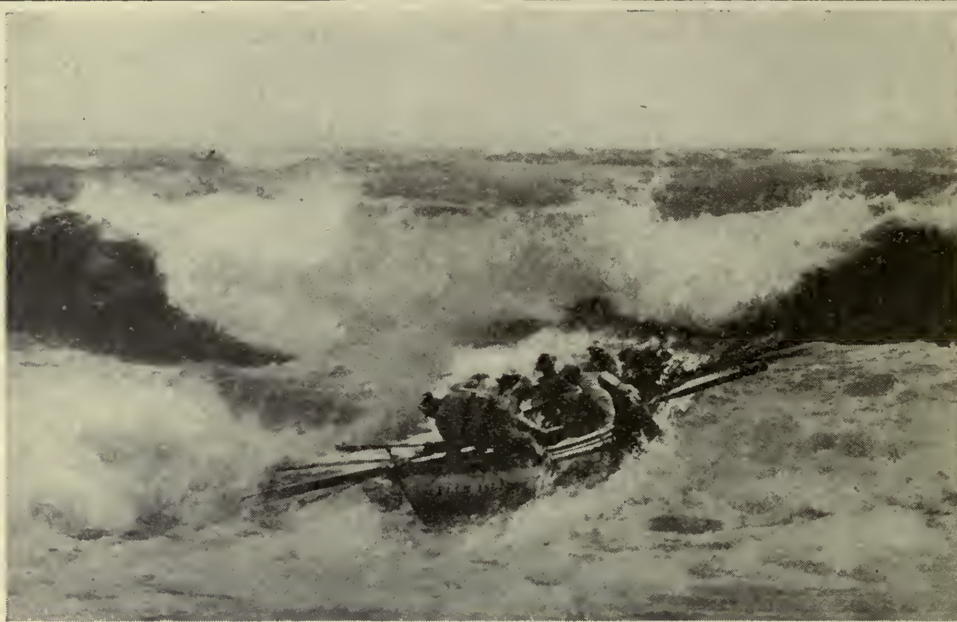
HOW THE COASTS ARE GUARDED

ALTHOUGH this service is the most important and, perhaps, the most dramatic rendered by the men of the lighthouses and their fellows afloat, it by no means comprehends the entire operation of their department. The United States has a larger number of lighthouses and a coast better protected by sea buoys than almost any other country. There are also many inland waters, such as the Great Lakes, that require protection.

Throughout the service, a high degree of skill is needed, and the men who follow this trade have the loneliest vocation in the world. They spend twenty-one days on duty in the lighthouse or lightship with nine days shore-leave. On such posts as the Diamond Shoals lightship, off Cape Hatteras, it requires stout hearts to resist melancholy. This ship is anchored about 300 miles from shore and has virtually no communication with the world outside or passing craft. Shore leave from a post like that is a matter of first importance and it is almost the only thing that breaks the monotony of existence. However, during the war, men serving on the Diamond Shoals light-

PROTECTION AT SEA

On the left is a lonely beacon of the sea, familiar and important to ship masters. It is interesting to note that radio, which has been turned so successfully to the aid of the navigator, through the sending of radio beacon signals from important marine outposts such as this, has also been applied to the good service of decreasing the loneliness of the crew at these outposts. Broadcast programs bring the life of the outside world to the crews at these stations. At the right the sea buoy at the entrance to Ambrose Channel. Above: dropping a four-ton "toy" buoy at its station



©Charles A. Harbaugh

A COAST GUARD SURFBOAT

Bucking a heavy sea to aid a distressed vessel. The dangers of navigation are constantly being lessened through the good offices of radio, now compulsory on most ships

ship had enough excitement to make up for days of dullness, when the ship was sunk by a German submarine. But all hands got safely to shore.

Most radio operators on the lightships have an interesting and often eventful life. They are expert men whose duties require a technical skill and a measure of intelligence of the first order. Robert Graeme, relief operator on the lightship at Fire Island and Ambrose Channel, is only twenty-three years old, but is looked upon as one of the ablest operators in the service. He has had six years of experience with radio operation, having learned his vocation in one of the navy schools, and he has conducted a number of experiments with radio transmission. "It's a great job," he told the writer, "and I get a lot of fun out of it." Mr. Graeme serves a month on each ship and then has a month ashore.

RADIO BREAKS SOLITUDE AT SEA

THE Ambrose Lightship is manned by a crew of old sailors, men who served before the mast in the days of the square-riggers when those with the hardest heads lived to be the oldest. That was long before radio helped to brighten the tedium of voyages around the Horn and through the far seas. But, as Captain Lange said, "The sea was the sea then. We had wooden ships and iron men. Nowadays they are mostly iron ships and wooden men. . . . You know," he continued reminiscently, "when I listen to radio programs I imagine myself ashore at the theater or a concert. And Sunday afternoons at three-thirty there is a program that reminds me of the days when I was a boy and used to sit in the village church, long before I ran away to become a cabin boy and finally an old sailor. But some of us have got to stay out here and keep the lights going. I have been forty-six years out of port and I suppose I would be lost at a land station. The sea is a hard master, but it's not easy to quit the sea once a man has sailed it."

He looked off to port with a wave of his hand over the stretches of heaving water, gray as a tern's wing. Just then the fog settled down and the mournful steam whistle broke into its sad refrain.

New Developments and Experiments with Receiving Circuits

By KEITH HENNEY

IN this article, Mr. Henney has some interesting things to say about reflexing and discusses the design of a five-tube receiver without the reflex. The analysis of radio and audio amplification, and in especial the recommendation of the use of power tubes in the last audio stage, will be found of great interest. Innumerable radio constructors have built the Roberts set, in the two-, three-, or four-tube layouts, and it is not breaking any confidences to say that the Roberts Knockout receiver is the most popular ever designed for home construction. In April, 1925, Mr. Henney's article, "Progressive Experiment With the Roberts Circuit," told of his experiments in our Laboratory on improvements and alterations in certain individual parts of the set. This entire article is, we think, a distinct contribution to the best current thought on radio design. The author is interested in hearing from readers who follow his recommendations, or who feel they have made helpful discoveries during the course of their work.—THE EDITOR

FOR the dyed-in-the-wool experimenter, there are few radio circuits that offer him more possibilities than the type of which the RADIO BROADCAST Knockout is a well known example. Here is a radio-frequency amplifier, a regenerative detector, a reflex, and an audio amplifier. Each of these component parts needs development, and offers fields of experiment for those so inclined.

In the April RADIO BROADCAST, a number of experiments were cited which were designed to improve the selectivity of the receiver as well as several features upon which the home constructor might work. Letters from readers have suggested other experiments, and the present article deals with what is going on in the Laboratory on this famous circuit and suggests other arrangements of apparatus upon which readers can experiment.

The business of making coils for this receiver has occupied the attention of many, and judging from the questions that have arisen on this point, it is a fertile field of work. Contrary to general opinion, there is no reason why the old fashioned solenoid coil cannot be used in this circuit. In fact it is quite probable that if the coils are well made, with a thought toward "low-loss", better over-all results will be

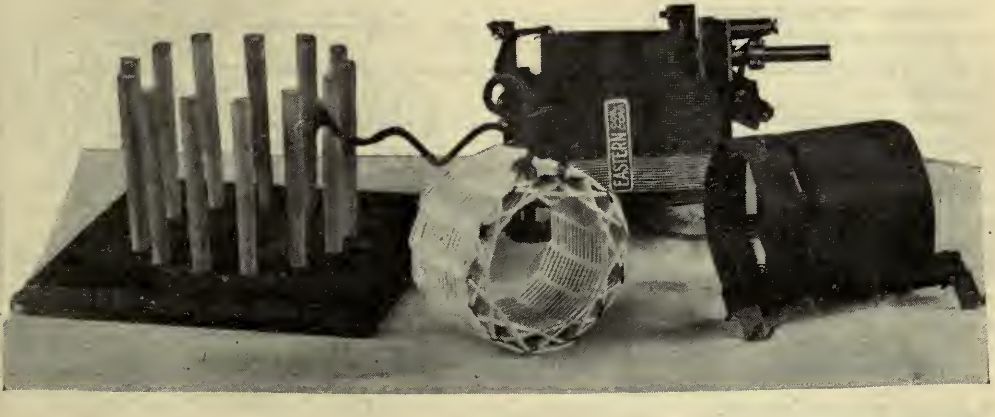


FIG. 1

Two types of coils that may be used in the Knockout receivers. The solenoid coils are wound on a form and the winding bound with passe-partout. The basket-weave coil form has an uneven number of pegs—and the more pegs the nearer the coil approaches a solenoid. The number of turns is four times the number that can be counted on a side. The coil illustrated has 64 turns and the mean diameter is three inches

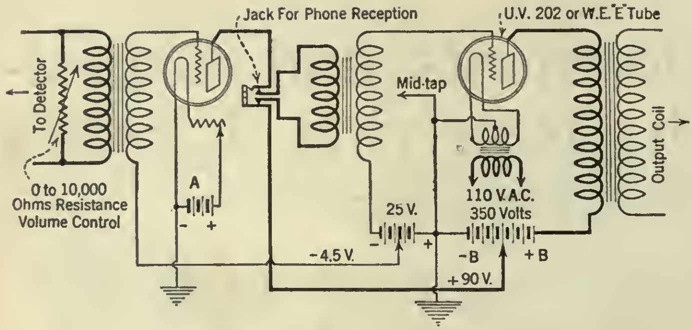


FIG. 2

A power amplifier to be added to a radio-frequency amplifier and a detector. The last tube is one that will handle at least 300 volts on the plate, and whose filament may be operated by alternating current by means of a step-down transformer. The quality of music transmitted by such an amplifier is a function of the transformers only since high enough C battery voltage may be applied to prevent overloading. The output transformer referred to in the diagram as an "output coil" is important since it keeps the heavy plate current from the loud speaker windings

obtained than by the use of other forms of inductances. Typical solenoid coils are shown in Fig. 1. and have the following dimensions to work with condensers of .0005 mfd. capacity.

Antenna coil, 50 turns No. 22 d.c.c., 2 inches in diameter, 2½ inches long.
Detector coil, 45 turns No. 22 d.c.c., 3¼ inches in diameter, 2 inches long.

If other sizes of wire and tubing are used, the constructor should consult the inductance-capacity chart given in the May Radio Broadcast, page 46.

In winding low-loss coils, the points to be remembered are these; use fairly large wire say No. 22 to No. 18; use as little dielectric as possible; space the wire about the diameter of the copper; and use solder sparingly.

Basket weave coils are illustrated in Fig. 1 together with a home made form upon which they may be wound. It pays to use rather large, well insulated wire here. The coils are stronger mechanically if the larger wire is used.

A FIVE-TUBE KNOCKOUT

MANY readers have requested information regarding the addition of an extra tube to the four-tube set. There are two places where this additional tube may be used, either as a stage of radio frequency amplification, or in the form of a separate audio amplifier by eliminating the reflex part of the original circuit. The first arrangement requires an additional coil and condenser but it is somewhat of a trick to attain successful operation due to the numerous feed-backs which result when two "high-powered" radio amplifiers are hooked together. This use of an extra tube is explained in the March Radio Broadcast, page 939.

By eliminating the reflex, the constructor gains several worthy points. The radio amplifier is free to give its maximum output, which is considerable if that amplifier is correctly designed; there is greater selectivity; the quality is somewhat improved—though the average loud speaker and the average untrained ear will not detect the difference—and the rumbling noises peculiar to reflex receivers disappear. The receiver will then consist of a straight radio amplifier, a detector with regeneration, and as much audio amplification as the builder desires to use.

On the other hand the receiver on two tubes will not operate a loud speaker, which is one

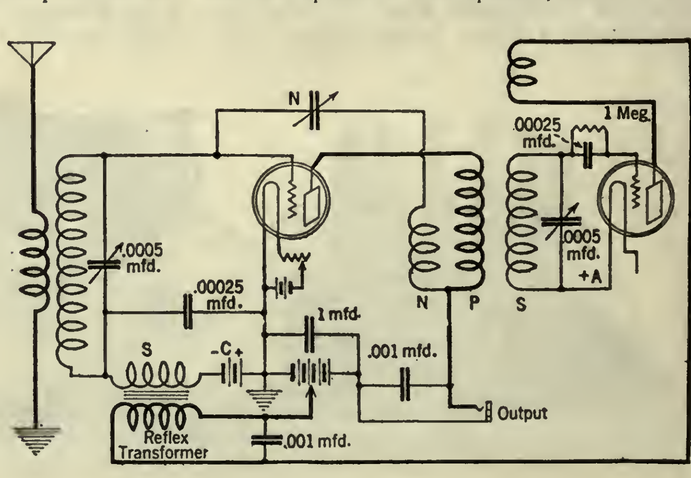


FIG. 3

The original and to date most popular reflexed radio amplifier. The by-pass condenser from tuning coil to filament tends to eliminate the higher musical tones, and the iron cored inductances in both grid and plate circuits of the first tube make an excellent audio oscillator at certain adjustments of tuning condensers

of the greatest advantages of Dr. Roberts's original design. The elimination of the reflex involves the additional cost in upkeep.

The English expert, Scott-Taggart, for many years the champion of reflex circuits, has changed his opinion recently on this subject. Quoting from *Wireless Weekly* for Feb. 25, 1925, one of Scott-Taggart's papers:

> I can forsee a fairly . . . distinct tendency to depart from reflex circuits altogether. I think the reduction in price of valves and the development of the dull emitter will do more than anything else to oust the reflex circuit from popular favor. The reflex is popular simply because the great demand is for signal strength with a minimum number of valves. Economy . . . is the one and only reason for the use of a reflex arrangement, and if we have the advantage of improving the selectivity and the range and generally making the set more effective, then an extra valve will probably be cheerfully added. A straight circuit will give better results in nine cases out of ten, than the same circuit condensed so as to use one less valve, the reflex principle being introduced.

In the opinion of the writer, the future set will require but four tubes, the last of which will be a power or semi-power tube whose filament will be lighted from alternating current and which will deliver enough output to operate the best loud speaker without overloading. Such tubes and the devices for operating them will be on the market as soon as home constructors have created a demand for them.

At the present time input push-pull coils are not so good as our best types of audio frequency transformers. A four-tube set would get around this difficulty. We would then no longer be troubled with much of the distortion now present in two-stage amplifiers and noticeable when low impedance cone type loud speakers are used.

An amplifier of this type is shown in Fig. 2.

It is a simple matter to eliminate the reflex in the Roberts receiver and Figs. 3 and 4 show the differences between the reflexed and the straight radio amplifier. The correct connections are indicated.

The increase in gain of the radio amplifier is quite noticeable and may be cause for trouble unless certain precautions are taken to prevent feed-backs. The coils, especially if low-loss, must be on the same plane and at right angles to each other. A good radio-frequency amplifier will oscillate if the grid and plate coils are an inch out of line. This is, in fact, a good test to see whether one has an amplifier that is giving full gain or not.

The gain in quality over the reflexed arrangement is due to the fact that the reflexed transformer secondary must be shunted with a rather large condenser which causes this secondary coil to resonate at lower frequency and naturally to lose those audio notes above about 3000 cycles.

The increase in selectivity is due to the decreased losses in the radio amplifier circuit which are large when an iron core coil is placed nearby, as in the reflex.

It is probable that the average voltage gain of the first tube with its accessory apparatus in a radio amplifier circuit will be about seven or eight, while the average neutrodyne has a gain of about three—which explains why these receivers have two stages of radio! If an amplifier is well constructed with plenty of plate inductance and is properly neutralized, it is possible to have a voltage gain of more than ten.

In the RADIO BROADCAST Laboratory, a five-tube receiver, without antenna or ground, gave comfortably loud signals on New York City stations 20 miles away, and on a short antenna equalled any receiver that was compared with it. A laboratory model is shown in Fig. 5

NEUTRALIZING THE ROBERTS

PERHAPS the most distinctive feature of the original Roberts circuit is the method of neutralization, namely, the double wound

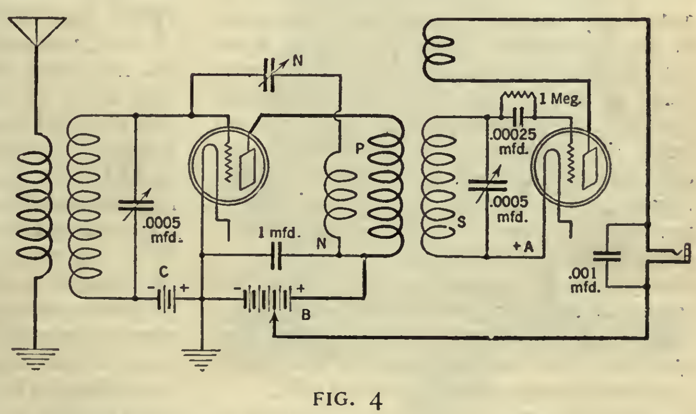


FIG. 4

The non-reflexed Knock-out circuit. The radio amplifier is now freed from audio frequency currents which occasionally modulate the incoming highfrequencies with considerable distortion as a result. The gain of this tube is increased over the reflexed arrangement—but one more tube is required

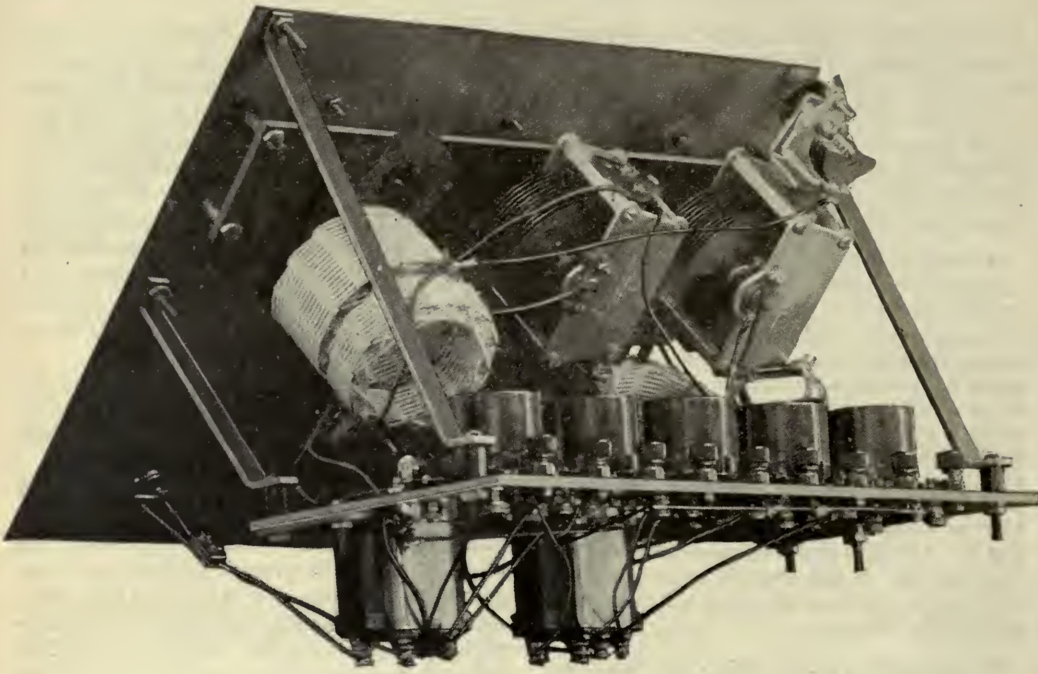


FIG. 5
A Laboratory model of a five-tube Knockout receiver

NP coil, or as it is used now, the mid-tap coil. If the audio frequency currents are removed from the first tube, as in the unreflexed set, neutralization becomes increasingly important, and experimenters will do well to investigate the various methods of capacity balancing illustrated in Fig. 6.

The double wound NP coil has one serious fault, especially when collodion is used as a binder. These two parallel wires have a large capacity which tunes with the inductance to give the coil a natural wavelength somewhere in the broadcasting band. The effect is immediate and obvious—the receiver refuses to tune to the lower wavelengths, it tunes broadly, and makes peculiar and irritating noises at certain positions of the two tuning condensers. One coil, whose high-frequency resistance was found in the Laboratory to be 300 ohms at 300 meters, was quite worthless, but became a highly efficient inductance when the midtapped arrangement was used. The resistance then dropped to less than 30 ohms, which is about average. The most satisfactory commercial coil sets now made for the Roberts receiver are equipped with mid-tap coils.

NEUTRODYNE NEUTRALIZATION

THERE is one advantage in the neutrodyne method of balancing out grid-plate capacity in that it eliminates the double sized NP coil. The presence of the large primary tends to broaden the detector tuning, due to capacity coupling and the mass of the metal in the coil being near the detector inductance. The neutrodyne method will not give any measurable gain over the Roberts. The tap on the detector coil should be near the filament end of the coil, and the neutralization will not be independent of frequency—contrary to general opinion.

THE RICE METHOD

THE Rice method as well as the Roberts system, possesses a distinct advantage over the neutrodyne method of neutralization in that all of the balancing apparatus, the inductance and neutralizing condenser, are kept within the amplifier circuit itself and are not carried on to the detector. The Rice method has another advantage because the neutralizing condenser is not attached to the grid but to the less critical plate, and if the exact center of the input coil is found, neutralization will be independent of frequency. The antenna-ground connections must be placed symmetrically with respect to the mid-tap if correct neutralization is to be maintained.

REGENERATION IN THE AMPLIFIER

AN INTERESTING point was discussed about a year ago in radio technical comment, regarding the policy of completely neu-

tralizing a radio amplifier. It was argued by some writers that a little regeneration in the amplifier was advantageous. Dr. L. M. Hull published an article on this subject in *Q. S. T.* January, 1924, which the experimenter should read and digest.

Dr. Paul Ginnings, of Greensboro College, North Carolina, has sent a useful device to the

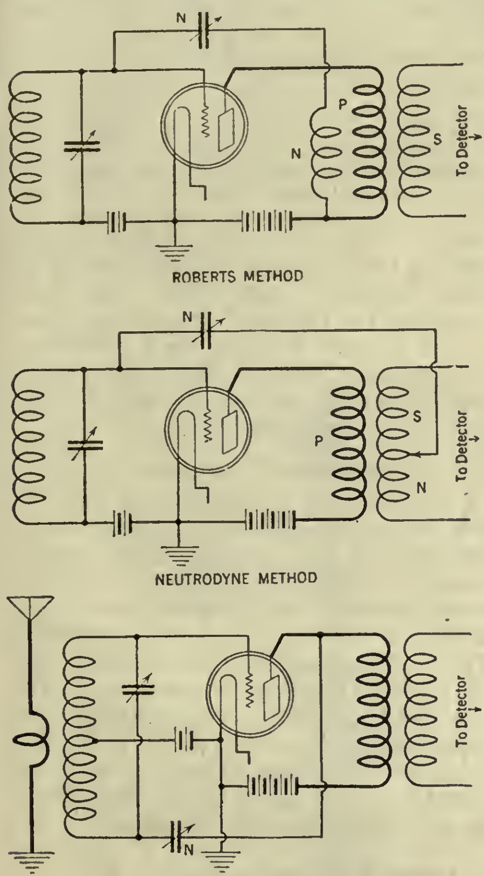


FIG. 6

Methods of neutralizing the radio-frequency amplifier of the Roberts receiver. The original N-P arrangement of Roberts is contrasted with the Hazeltine and Rice methods. The advantages of these three systems are outlined in the text

Laboratory which is designed to introduce a given amount of regeneration into the first tube of the Roberts set. A diagram of the connections is shown in Fig. 7 and a photograph in Fig. 8. What Dr. Ginnings condenser does, is to add a constantly increasing amount of regeneration to the amplifier so that the longer wave stations will be received with greater strength than ordinarily. In practice, the device consists of an additional

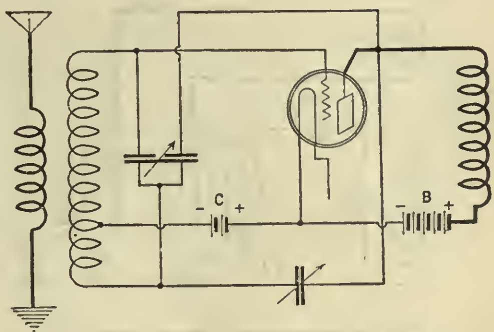


FIG. 7

Dr. Ginnings's method of introducing regeneration into the radio amplifier of the Roberts receiver. The reception of the longer wavelength stations is improved by this method. The double condenser shown is the tuning capacity to which is attached a single plate which is connected to the plate circuit. The tap is placed so that the ratio of turns is about 6 to 1

plate attached to the amplifier tuning condenser which is so adjusted that oscillations are just prevented at the lowest wavelength to be received. Then as the tuning condenser is adjusted to the longer waves, more and more unbalance is attained through the extra condenser.

DETECTOR REGENERATION

SEVERAL interesting methods of introducing and controlling regeneration in the detector circuit have been used recently in

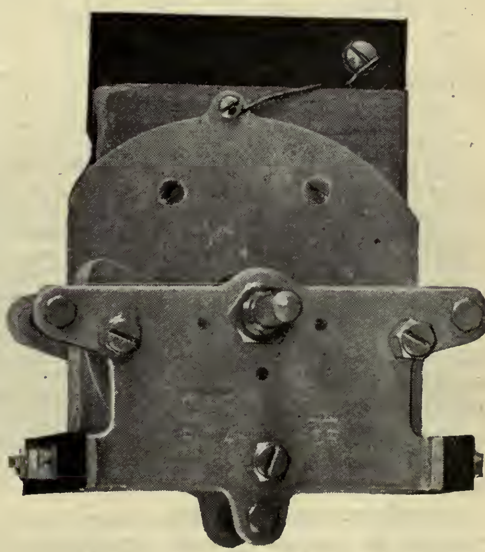


FIG. 8

A photograph of Dr. Ginnings's device. The method of attaching the feedback condenser is shown

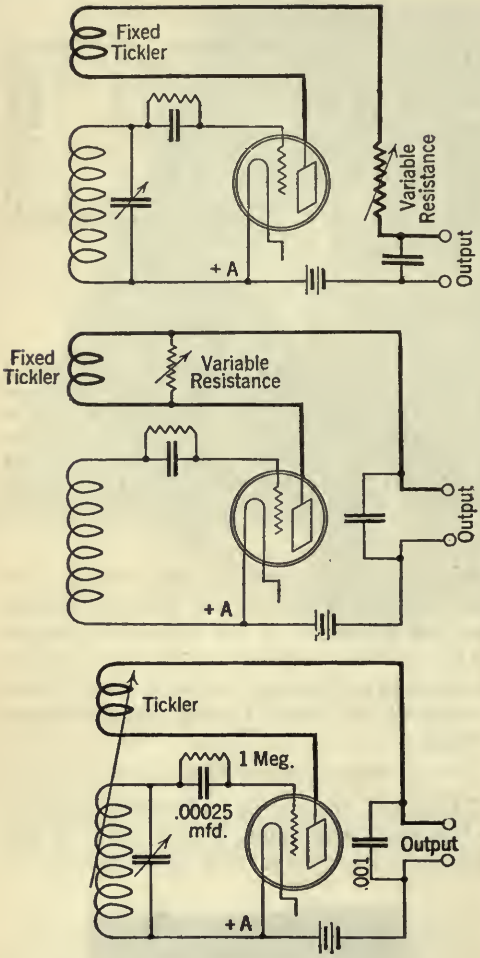


FIG. 9

Methods of introducing regeneration into the detector. The familiar tickler is contrasted with two methods of avoiding the mechanical difficulties incident to a variable inductive feedback. A Bradleyohm, a Clarostat, or any resistance variable from a few ohms to a few thousand may be placed across a fixed tickler and affords a smooth control

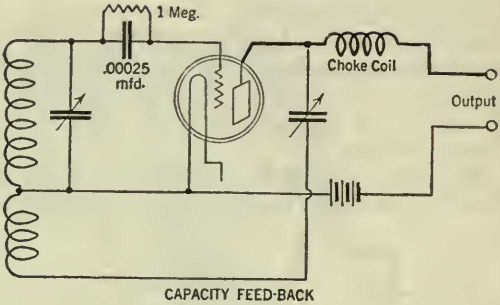


FIG. 10

A condenser may be used to introduce regeneration in connection with a fixed tickler coil. Here again the control is more even than with the conventional "floppy" tickler

the Laboratory. Fig. 9 shows the conventional tickler feedback and two systems for avoiding the variable coupling between tickler and detector coils.

In practice, the tickler is fixed in position so that oscillations will occur on the longest wave to be received without resistance control. Then, by adjusting the resistance, either shunt or series, oscillations may be secured on other wavelengths. This regeneration is fairly independent of frequency—which is not true of the usual "flopping" tickler system—and should not affect the tuning of the detector circuit. In the five-tube receiver, this is particularly valuable since there is less danger of unwanted coupling back to the amplifier than with the moving tickler coil.

CONDENSER FEED BACK

A VARIATION of the resistance control is the condenser feedback, probably due to Weagant and used commonly in the Reinartz circuit. A fixed coil is placed near the detector secondary and coupling to the plate is effected by means of a series condenser. The condenser and coil is then a shunt path for the radio frequency currents, and a choke coil may be necessary to keep these currents from escaping through the phones or amplifier primary. The circuit is shown in Fig. 10 and a drawing of a choke in Fig. 11. There should be no condenser across the output in this

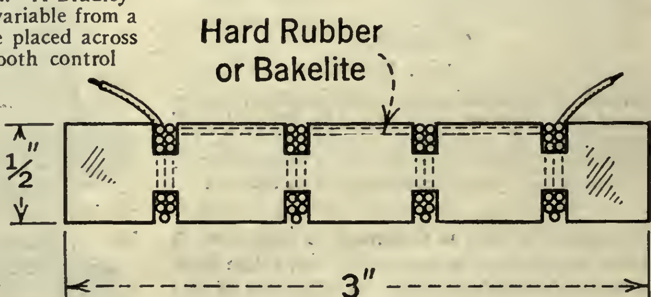


FIG. 11

A drawing of a choke coil to be used in connection with condenser feed back. Fine wire may be used and up to 100 turns may be placed in each slot. The number is unimportant, and the choke itself may be eliminated if oscillations occur without it. Possibly the radio frequency currents will be kept in the feedback circuit by the impedance of the telephones or audio transformer in which case the choke is unnecessary

arrangement. This method of adding regeneration is particularly smooth in operation, and it avoids the movable tickler with its varying field.

TUNED PLATE FEEDBACK

ANOTHER effective method of adding regeneration is shown in Fig. 12. This is the tuned plate scheme popular with amateurs for many years. The coil and condenser may be of the same dimensions as the detector tuning elements, and if this is the case, the dial readings will be about the same at various frequencies.

This system is particularly effective when using toroid coils since it obviates the necessity of tapping the inductances—which would destroy the toroid effect.

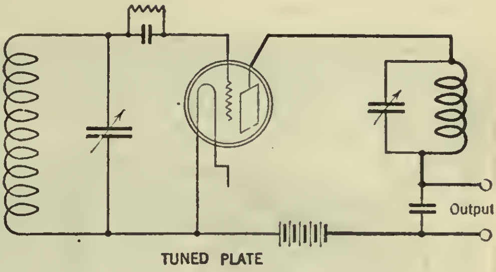


FIG. 12

The old method of tuning the plate circuit to the same frequency as the grid circuit. Oscillations will occur, and if this plate circuit has somewhat higher resistance than ordinary, oscillations will be controlled very easily. It is possible with this arrangement to have the tickler dial read like the tuning dials

WIRELESS COMES TO THE LIGHTSHIP

The English lightship No. 67 at Haisbro is one of many in the British and other services to be equipped with radio receivers to entertain the crews while they are anchored at their lonely stations. Many of these ships are equipped with automatic radio transmitters which transmit radio fog signals on 299 kc (1000 meters). The United States has particularly led in this respect, and many lightships on the Atlantic and Pacific coasts and the Great Lakes have "radiophares" or directional wireless signals for ships

SO THIS IS VENICE!

The directorate of the Venetian "Rapid Transit Company" is equipping all of its conveyances with radio receivers. Patrons will in future be provided with timely entertainment in the event of a tie-up

THE MARCH OF RADIO

By J. H. Morecroft

Past President, Institute of Radio Engineers

The Horizontally Polarized Wave—Another Radio Bombshell

WE HAVE all become familiar with the vagaries of energy transportation by radio waves and have practically schooled ourselves into the idea that fluctuation and fading of signals is one of their characteristics and thus not to be remedied or be done away with. But also we have learned that scientific attack on many of radio's problems has frequently yielded valuable results in the past, so when a recognized authority puts forth a new idea or radio theory we are ready to accept it, strange and odd as it may sound at first.

As an illustration of how our radio ideas have been upset, we have only to think of the directions in which radio waves are supposed to travel. Textbooks tell us that these waves travel out from a station in a straight line, becoming less intense with increasing distance. But many features are now known to affect this. Measurements of signals from WEAF, for example, in the vicinity of New York City show that at many places the signals come from directions at right angles to the expected one and further, that signals may increase in intensity with increasing distance instead of diminishing as they should. So we have to be ready to accept other odd ideas if they are based on experimental fact.

Engineers of the General Electric Company

and the Bell Telephone Laboratories have recently been carrying on some most fascinating work to determine exactly what happens to radio waves as they travel along. We can see a water wave as it goes over the ocean surface, see it twist and turn around a projecting pier or rear itself and fall over on a sand bar, but to find what happens to radio waves, our eyes are not very helpful. Delicate vacuum tube apparatus and wonderful oscillographs are necessary to show photographically the electric currents which tell us definitely of the action of the radio waves.

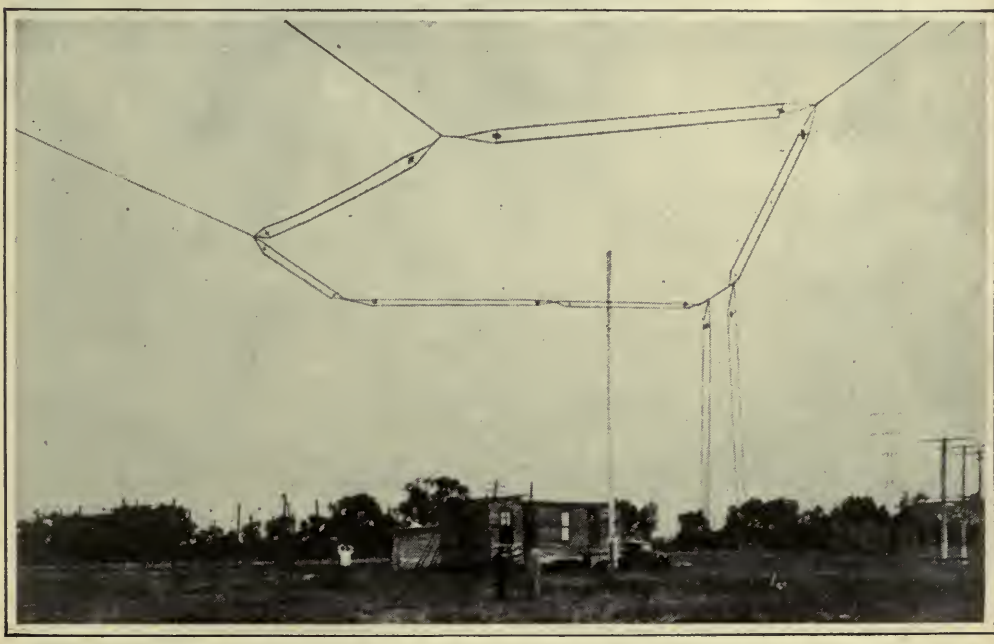
Interpreting the pictures they have obtained, the research engineers now tell us that the radio waves twist and turn as they travel outward from the station—that in some places a vertical antenna will pick up more power than the usual horizontal kind. Furthermore, at some instance the horizontal antenna may be better than the vertical one and then, as the amount of twisting of the waves changes, the reverse may be true.

According to E. F. W. Alexanderson, consulting engineer of the Radio Corporation, this haphazard twisting accounts for much of the rapid fading to which some signals are subject and he suggests a possible remedy. To use two transmitting antennas is apparently his idea, one of them to be a horizontal one and the other a vertical one. Then as these two waves travel out from the broadcasting station, their total effect on the receiving antenna will be about the same no matter how much twisting the wave has suffered. In his opinion, a scheme of this kind will do much to lessen fading. At the same time, it should increase the ratio of signal strength to static; which is the same as though static had been to some extent eliminated.

Mr. Alexanderson refers to this second, and aiding radio wave as horizontally polarized. It is interesting to note, in this connection, an article by Walter Van B. Roberts, "Can Static Interference Be Eliminated?" in RADIO BROADCAST for December, 1924. Mr. Roberts, in that article, reviewed methods for the elimination of static interference and suggested, among other things, that horizontally polarized waves might offer a solution to the difficulty.

Radio, the Handmaiden of Explorers

CERTAINLY no explorer ever started on a polar expedition with the assurance reasonably assumed by Mr. Donald MacMillan on his latest venture into



E. F. W. ALEXANDERSON'S ANTENNA

With which he is carrying on extensive experiments in his laboratory at Schenectady in radiating horizontal polarized waves. It is possible that his and others' experiments will result in the diminution of static and fading, two of the listeners' deadliest foes

the unknown seas around the North Pole. A few years ago he would have left civilization with the reasonable certainty that he would not hear white men again for perhaps two years; all that time his triumphs and disasters would be known to him alone, those at home blindly trusting to his ability to return when his self imposed task was finished. If he was not heard from after a year or two a relief expedition might start out with the slim hope of picking up his trail and giving what aid they might.

On the present expedition, radio is keeping the explorer's friends constantly advised of his progress; both ships of the expedition are well equipped with apparatus designed specifically to best maintain the polar radio channels open. The experience with radio gained by MacMillan and his operator, Donald Mix, on the previous expedition was such that short waves are to be largely depended on during the present trip. Frequencies from about 2000 kilocycles up will be used, the highest being 15,000 kilocycles (150-20 meters). Only specially designed receiving sets will pick up such high frequency signals, for even the lowest of these frequencies is very far beyond the highest useful frequency of broadcast receivers.

Already the peculiar conditions discovered on the last trip have been re-encountered. As this is written, the *Bowdoin* and the *Peary* are in the Greenland ice fields, not isolated as previous explorers have been, but in easy communication with those at home. Instead of reaching the eastern coast of the United States, however, the radio messages are already veering west, and again the operators in Washington, British Columbia, and Iowa, are the ones who have to relay MacMillan's messages to us. His compass pointed due west—a fact that makes us well appreciate how far from usual are the experiences through which these northern explorers pass.

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L. A. CORRIDON

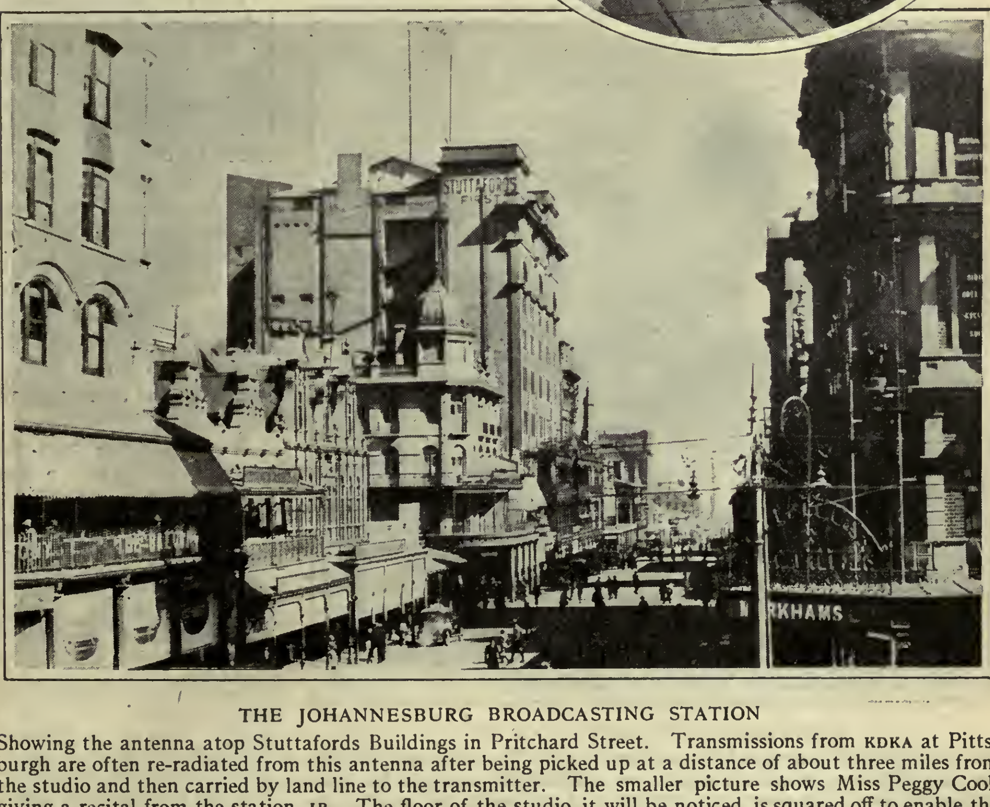
Of the Department of Commerce who is responsible for the selection of all new call letters for broadcasting and telegraphy stations. The fact that he is tied down to the initial letters, N, K and W, makes this no simple matter

How the League of Nations Aids Radio

IN SPITE of the assertions of many of our politicians that the League of Nations is dead, it seems to be gradually working out problems which, without the international coöperation the League guarantees, might be the cause of much bad feeling. Of especial interest to us is the attack being made on the radio broadcast problem. With our 561 broadcasting stations, the interference problem is by no means as important and difficult question as it is in Europe with its fifty odd stations.

With the possible exception of a small part of our northern border, the interference between various stations in America is national rather than international. Hard feelings, if any are really engendered, are not of international significance and can lead to no serious trouble. In Europe, however, the fifty odd stations may cause a tremendous amount of international dissention. The countries are so small, and so close together, that a station of any one country is very apt to reach out into all the others. The band of frequencies available for broadcasting in Europe permits of only forty-two channels, so that with the fifty-seven stations operating, some interference is almost sure to occur.

The technical committee of the International Radiophone Union acting under the auspices of the Communication Section of the League of Nations, has just met to discuss and act upon the European broadcast situation. Taking up the interference question in a reasonable and amicable manner, the com-



THE JOHANNESBURG BROADCASTING STATION

Showing the antenna atop Stuttafords Buildings in Pritchard Street. Transmissions from KDKA at Pittsburgh are often re-radiated from this antenna after being picked up at a distance of about three miles from the studio and then carried by land line to the transmitter. The smaller picture shows Miss Peggy Cook giving a recital from the station, JB. The floor of the studio, it will be noticed, is squared off to enable the director to place the artists to best advantage

mittee decided that with the amount of information avilable, a proper solution of the problem was not possible. It was decided that during the next two months, extensive testing would be taken up, on regular schedules after the broadcasting hours, to accumulate the necessary data on the interference effects. Two months experimenting are necessary in the committee's opinion and so the session was adjourned for about this length of time, after which another meeting will be called to further analyze the question. We are glad to see that, to all appearances, European interference will be settled in a friendly manner in spite of the international, and therefore vexatious, questions involved.

The News Value of Broadcasting

PROBABLY never before has radio performed such a countrywide service as when the news about Mr. Bryan's death was broadcast. Whether for or against him there was none of us who could help being interested in the passing of this noted American. His death came so suddenly and unexpectedly that it made the service of radio seem even more striking than it has been on other occasions, when a previously announced event has been spread over the country.

On Sunday evening, the radio audience is probably larger than at any other time and, as every important broadcasting station was at once notified by telephone, telegraph or radio of Mr. Bryan's death in the obscure Tennessee village, it seems not at all unlikely that within a few hours of its happening, from five to ten millions of his countrymen had been notified of the sad event.

"Weeding Out" in the Radio Trade

A RECENT summary of the midsummer conditions of the radio industry shows that although many of the smaller companies must succumb as a result of over production, and consequent cut price disposition of their stock, many of the companies, by pooling patents and credits, consolidation of manufacturing facilities, etc., are putting themselves on a reliable and trustworthy basis for the resumption of trade in the fall.

WHAT ARE THEY LISTENING TO?

Or are they merely resting between "paddles"? The photographer tells us that the two youngsters are enjoying the music provided by their radio, but we fail to detect any antenna and we hardly suspect that an enclosed loop would give satisfactory results with a neutrodyne receiver

When we consider the extraordinarily rapid growth of the radio business, it seems remarkable that even more business failures have not occurred. In 1920, the radio business was estimated at two million, in 1921 five million, 1922 sixty million, 1923 one hundred and twenty million, and in 1924 three hundred million dollars. The estimates for the radio business for the present year go as high as four hundred and fifty million.

A short time ago the stock exchange saw a new radio stock practically every day, and during this year about five million shares of radio stock were sold to the public. The advertisements of this stock were generally worded to indicate that reliable business regarded them as a gamble, but the public was willing to take a chance, and did so. Comparison of the original selling price of

TWO PROMINENT BRITISHERS

On the left is J. C. Reith, who is the managing director of the British Broadcasting Company and a popular figure among the British listening public. The Right Hon. F. G. Kellaway is shown in the second photograph. He succeeded Godfrey Isaacs as managing director of the Marconi Wireless Telegraph Co. Ltd. and the Marconi International Communication Co. Ltd.

the stock with the present quotations show that the trusting public has already suffered a paper loss of more than $100,000,000. Probably this loss will be a real one and of even greater magnitude before the radio business is completely stabilized.

Present estimates—all of them founded on no especially reliable facts—place the number of radio sets in the hands of the public at 2,500,000, and as we have about 9,000,000 phonographs in our homes, and 12,000,000 automobiles, it is evident that for those companies which make reliable apparatus and which are properly financed to stand the periods of depression, there is still plenty of market left to absorb their products.

Radio in Foreign Countries

FROM the Department of Commerce comes a summary of the radio situation in foreign countries, compiled for the benefit of American manufacturers who are seeking to do export business.

In Austria, where broadcasting began a year ago, much interest is displayed, and it is estimated there are at present fifty thousand receivers in use; most of which are of home manufacture due to the high tax imposed on imported sets. The broadcast listener must obtain a license before using a receiving set. The license costs at the present rate of exchange about fifty cents a year.

In Czecho-Slovakia, a broadcast station of five kilowatts capacity is about to be erected in Prague. If receivers of the type common in America are used, this station should reach over most of the country.

In Spain there is a considerable demand for radio apparatus, due largely to the operation of two broadcasting stations in Madrid. Although most of the receiving apparatus is of British and French origin, the American manufacturer can well afford to go after this market. In the first quarter of 1925 more than $100,000, worth of American apparatus was imported.

In South America, Argentina continues to lead, possibly because the government has not as yet put any restriction on the use of radio receivers. It is claimed that practically all the radio apparatus used there is of American manufacture.

New Zealand has just put in several broadcasting stations and the number of radio receivers is rapidly on the increase. It seems that most of this apparatus must be of home manufacture or else of British origin as the imports from America for the first quarter of 1925 totaled only $23,700.

Our commercial attaché in London reports that although but little American apparatus is as yet used in England he believes that there will be a considerable market for highly sensitive sets which will be sought only by the "distance hound" because those who listen only to local stations do not require multi-tube receivers. There are twenty-two stations on

the mainland, only as large as New York and Pennsylvania combined, so that no listener is very far from his closest station.

Is Canada Showing Us the Way?

WE ARE glad to notice that some of our Canadian friends have earnestly taken up the fight against radiating receivers. The position of this magazine on the question has been stated repeatedly and we are glad to commend our northern neighbors for the attack they have started.

The Victoria Radio Club of Victoria, British Columbia, have sent their views on the question to the Dominion government in the following letter:

Honorable, the Minister of Marine and Fisheries,
Dominion Government,
Ottawa.

Sir:

Whereas in the opinion of the members of the Victoria Radio Club, the use of radiating sets has become a public nuisance, it is the opinion of this club that some government action must be taken.

We believe that the manufacture and sale of radiating sets in Canada should at once be stopped by law, that on all licenses the type of receiving set used should be specified, and, in reasonable time, the use of all radiating sets absolutely prohibited by law. Also that all radio inspectors be given full power to act at once in case of persistent interference.

Yours truly,
Victoria Radio Club.

The Month in Radio

THE Bureau of Foreign Commerce in Washington reports the successful transmission of energy by radio, the feat having been accomplished by an Italian inventor. The radio waves he used were so short that the kilocycle becomes an inconveniently small unit for expressing their frequency. In wavelength, so the dispatch states, the radio wave resembles a light wave rather than a radio wave, the length being only about one hundred millionth of a meter. Remembering the "achievement" of another Italian inventor, who, during the war, was to explode submerged bombs from great distances by the use of a ray much the same as this, we would not even mention the present dispatch if it had not come to us in a Department of Commerce communication. It is only a short time ago that the inventor of a wonderful "death ray" had headlines in all of our newspapers but to the best of our knowledge he never showed a single experiment to back up these claims.

CONGRESSMAN SOL BLOOM of New York has just announced that he is about to lead a battle to purify the ether from the taint of radio advertising. At the next session of Congress he will introduce a bill abolishing all advertising through the broadcast channels. He denounced the exploitation of the radio public by advertisers in no uncertain terms. We hasten to point out to him that he would be wise to proceed slowly. The public will never get something for nothing and so if they are to get a good musical program without paying a cent for the artists, it will probably be necessary to listen to the name of the donor of the hour's entertainment. This indirect advertising, if well done, is not at all disagreeable. If Mr. Bloom is successful, he will legislate away our best radio entertainments.

JUST why the police should permit a demonstration of a radio controlled car on crowded New York streets is a mystery, yet just that did happen. On one of New York's busiest thoroughfares an automobile, controlled by radio from another car a few yards away from it, was allowed to careen its way against traffic, making other cars climb up on the sidewalks to avoid collisions, narrowly missing a fire engine, and finally plunging into a photographer's car.

There is nothing remarkable about such a demonstration except the foolishness of the police in permitting it. The remote control of vehicles, boats, and even aeroplanes has been accomplished many times before, but never before on a crowded city street.

THE Navy Department, which is temporarily carrying on commercial radio business across the Pacific, announces that traffic to Tahiti is now possible. From our west coast to Hawaii, then to the Samoan Islands, and so to Tahiti, the radio reaches over the expanse of the Pacific.

AT THIS year's commencement of Union College, the Bailey prize, given each year to that senior who contributes most to the college, went to Edward B. Redington, who had carried on experiments in the generation of very high frequency oscillations by

vacuum tubes. By using very short connections for inductances and in place of an ordinary condenser utilizing the capacity between the grid and plate of the tube, he was able to obtain frequencies as high as 80,000 kilocycles (3.8 meters) using fifty-watt tubes. Those who have tried to make large tubes oscillate at very high frequencies realize the difficulties which the young researcher encountered and feel that he well deserved the prize.

IN LONDON, a bill has just passed Parliament which makes it illegal to make phonograph records from radio signals. It is said that many well known artists have refused to sing over the radio because of the possibility of records being made in this way, and quite naturally the artists are not anxious to "stand for" the indifferent quality the average radio set gives.

THE city of Philadelphia has just awarded William G. Housekeeper of the Bell Telephone Laboratories, the John Scott medal for his contribution to technical progress. The award carries with it a $1000 prize.

By this public award, Mr. Housekeeper is recognized as the one responsible for the development of the metal-glass seal which was the one step required to increase the capacity of triodes from one kilowatt to one hundred kilowatts or more. As previously explained in these columns, to seal successfully a large copper thimble to a large glass tube was impossible until Mr. Housekeeper discovered that if the edge of the copper tube was made very thin where it met the glass, the joint would not crack, as was always the case when this simple expedient was not resorted to. Copper and glass contract to different degrees on cooling so that the joint has always cracked as the glass cooled down, thus spoiling the vacuum tube. If, however, the copper tube is drawn to a thin edge where it meets the glass it becomes sufficiently elastic that as the cooling glass tries to pull away from it the copper yields and thus permits the joint to stay air-tight.

The Misuse of a Municipal Broadcast Station

ABOUT a year ago, when the mayor of New York City was contemplating the installation of a municipal broadcasting station, we pointed out the very likely misuse to which such a station could be put by unscrupulous politicians. We don't yet appreciate either the importance of a broadcasting station of this stripe nor yet its proper economic classification.

PREMIER STANLEY BALDWIN

Delivering an address which was simultaneously broadcast from every one of the British broadcasting stations. The occasion was the recent rally of more than 100,000 persons at Welbeck Abbey, celebrating the signal victory of conservatism under Premier Baldwin. Note the two microphones which are enclosed within the boxes in front of him

GOVERNOR ALFRED E. SMITH

Of New York State

"The American democracy covers so vast a territory that we must heartily welcome an art that brings its executives and legislators into the most immediate contact with the public they have been elected to serve. The advantage is double. Radio expedites the sending of an intimate message to the whole body of citizens and it secures to the speaker a more prompt and frank expression of personal opinion than he could obtain in any other way. Thus there is preserved a mutual relationship that is of especially high value as new problems arise which can best be solved by a renewed meeting of minds.

"Recent experiences in broadcasting matters of public moment through the medium of WGY *have given me a new sense of close fellowship with my fellow citizens; their many replies have been an inspiration in seeking a solution to the questions which an executive can conscientiously answer only in the full light of the common thought."*

Is it a proper use of public funds to establish such a publicity medium, which can so easily be used to wage warfare on those who incur the disfavor of the temporary municipal rulers? This question has been brought up in the case of WNYC, New York. A citizen claimed that the establishment and maintenance of the station was a misuse of the city's funds. In the suit against the city authorities, the plaintiff's attorney states that:

the City of New York, and the defendants are without authority to expend or use the funds of the City of New York for the purchase, construction, or operation of the station. That there is no authority in law for broadcasting official reports by radio, the publication of such reports being otherwise provided for. That there is no authority for the use or expenditure of city funds for the broadcasting of political propaganda on behalf of the defendant or any other person or persons.

That unless restrained the illegal acts of the defendants will continue. . . .

More than a year ago, Mr. Grover Whelan, then Commissioner of Plants and Structures, through whom the Mayor's orders regarding the station were carried out, made a public statement of what the station's activities were to be. Said he, when the station was being installed,

editorial writers are now concerning themselves with the possible misuse of the municipal station. Let me assure these gentlemen that no administration would be foolhardy enough to invade the sacred precincts of the homes of its people with any political propaganda. . . .

The complaint states that "the purpose and use of this broadcasting station have been utterly different from what was indicated in the above statement and it has been used repeatedly and continuously for grossly improper political propaganda."

The city officials have given out reports which are supposed to show that the material sent out over the broadcast channel was entirely non-partisan. Any listener who has heard the political "news" broadcast from station WNYC knows the facts to be otherwise. Fulsome praise of the city's mayor has always been a dominant note of the so-called "news of the day" and violent attacks on any who dared question his actions have always been used to accentuate his wisdom and his thoughtfulness for the city's dwellers.

The actual situation is readily made clear when one recalls that any talk to be sent out over WNYC's channel has to be written out beforehand—as is true of almost every first-class station—and submitted to the mayor or his hirelings for criticism and correction before being delivered. The Mayor or his commissioners are quite free to say what they want to on any subject uppermost in their minds.

Supreme Court Justice Churchill denied the injunction asked by the Citizen's Union, the body behind the movement, to confine the use of the station to proper activities. In his decision, he states that "it was within the discretion of the legislative bodies (of the city) either to confine the use of the station to the administrative work of the city's officials or to permit a wider use." The court also asserted that it was "a question which no court

has a right to consider." So that evidently the taxpayer in New York has no redress; if he doesn't want to hear what a wonderful mayor the city has had for the last seven years and reasons for putting him back in office, his only recourse is to tune-in on other channels.

The course of events following the opening of this municipal station is exactly as we predicted it would be when discussing its installation; while ostensibly of service to the police and other departments its most important function may be to spread political propaganda for those in office.

The Radio Corporation Announces a Deficit

FOR the first time in its history, the Radio Corporation of America has reported a deficit. Its expenses for the second quarter of the year exceeded its income by nearly $400,000. This is the first check in a remarkable growth, and one almost without parallel in financial circles.

Up to 1921, the Radio Corporation retained its original character. Founded during the war to improve the overseas communication channels for the government, for several years it was essentially a transoceanic communication company with a comparatively small business. Even the total transoceanic communication business is not very large and of course the radio channels got only a resonable fraction of the total. In 1921, when radio broadcasting began, the total business of the Corporation was less than $1,500,000. Last year, its business totalled $50,000,000. Such a rapid growth has seldom been seen in the industrial world.

During the first quarter of this year, the earnings of the company were $15,229,923, which, with expenses of $13,301,594, left a comfortable surplus for dividends. But the second quarter showed earnings somewhat less than $4,600,000, and the expenses were nearly $5,000,000, leaving a deficit for the quarter of $391,053. This report shows the high seasonal character of the radio business and serves to emphasize the fact that a company must have a good deal of financial reserve or else carry on at the same time some other business which fills in the slack periods of the radio season.

It is quite evident that the Radio Corporation is feeling the pressure of competition and the tremendous unloading of sacrificed stock which many of the smaller companies were forced to carry out this summer. Unlike the smaller companies, however, this great corporation has sufficient reserve power to stand several such temporary setbacks.

EDWARD H. JEWETT

Detroit; President Jewett Phonograph and Radio Company

"There is no question about the public's having purchased a terrible lot of junk in the past years, believing, of course, that they were buying reliable radio apparatus. It has not given them any satisfaction and it certainly has done the radio industry harm.

"Be sure to go to a dealer in whom you have confidence and then add the caution of comparison. Gear your actions to what you hear demonstrated, not to what you are promised. I am sure that if any one of you were out to purchase a trotting horse, for example, and the seller said the horse could make a mile in two minutes flat, you would not make the purchase on such hearsay. More likely you would say, 'Is that so? Let's see the hound do it.'

"Approach your radio purchases the same way. Remember that you are buying something you will want for a long time and apply that thought to the measure of what you spend. The difference between cheapness and economy is almost the same as the difference between disgust and satisfaction."

Where is the Channel Cable?

NOT long ago we enthusiastically reported the success of an experiment which, although not belonging strictly in the radio realm, was sufficiently close to it to be classed by many as a new conquest for radio signalling.

On many occasions the traffic in our im-

portant harbors is held up for hours and sometimes days, by heavy fogs. Where the channels are narrow and winding, the cautious pilot generally holds up his ship until he can see the familiar landmarks. These delays of course are very costly to steamship companies and aggravating to homecoming passengers so that the public hailed with delight some months ago the announcement of a new scheme for piloting ships into harbors in spite of fog.

An insulated electric cable laid on the bottom of the channel, carrying alternating current of about 500 cycles frequency, was to act as a guide to the fog-bound ship; large coils carried on the ship's sides were to be used to pick up the alternating magnetic field surrounding the cable and by suitable setting of these coils, as the received signal was heard in a pair of head phones, the ship could be held on a course right over the top of the submerged cable. As this was laid in the center of the channel, the scheme (at least on paper) seemed sure to permit the pilot to bring his vessel up the harbor no matter what the weather conditions might be.

After the successful experiments were reported, it seemed certain that the scheme would be put into operation. The cable installation could not be very expensive and the apparatus required on board ship was so cheap and simple that its immediate application in important harbors seemed almost certain. But either the reporter responsible for the story of the successful tryout was too optimistic or else the pilots refused to accept newfangled ideas, otherwise we should not read in a current paper that "fifteen steamers, including eight passenger liners, lie off Ambrose Light waiting for the fog to lift." The Ambrose channel is exactly the place where the successful cable tests were carried out.

Interesting Things Interestingly Said

SULTAN CHINEY (Bombay; interviewed during his recent visit to this country): "At present there is no commercial wireless in India but we have recently started the India Radio Telegraph Company, Ltd., and obtained all the rights of the Marconi Wireless Telegraph Company with their affiliations in America, Germany, and France, and are putting up beam stations to connect in the first instance with England and then America and gradually with the rest of the world. The Goverment of India is going to give a single license to one company, such as the British Broadcasting Company has received for England. Interest in radio has become tremendous in India and there are many radio sets in use, some of them of American origin. But we have a large population and one difficulty that confronts us is that if we wish to make everybody understand what we are broadcasting, we shall have to use about nineteen languages. I rather think we shall have to concentrate on two—the Hindu and English.

DR. J. H. DELLINGER (Washington, D. C.; Chief, Radio Laboratory, Bureau of Standards): "There has been considerable discussion over the question of regulating the character of programs sent out by broadcasting stations. The Government has consistently opposed censorship, and the result is that the stations are entirely free in their choice of material. The radio broadcasting system of the United States can be characterized as one of extreme freedom. Any one is free to erect a broadcasting station and no license or regulation other than patent right is imposed upon the sale, purchase and use of receiving apparatus. This accounts in large measure for the remarkable growth of radio broadcasting. It is also responsible for the principal difficulty in which broadcasting finds itself at present, the existance of too many broadcasting stations."

BISHOP JAMES E. FREEMAN (Washington; National Cathedral): "More and more am I coming to the conviction that, through the medium of radio, we are to bring about, among all types and classes of our people, not only a better understanding, but a finer spirit of unity and comradeship. In the course of a ministry covering thirty-one years I have never had a greater evidence of the widespread interest in religion—and that from all types of people—than during the year and a half in which we have been broadcasting our services from the National Cathedral in Washington."

MARTIN P. RICE (Schenectady; manager of broadcasting for the General Electric Company): "Radio programs are slowly but surely improving. The listening public is becoming more discriminating and exacting. The advertising program is being weighed in the balance of public favor and it is doubtful if it will be accepted. More skill, art and talent are needed to make advertising by radio successful. Good music is appreciated everywhere, and the stations broadcasting it are always popular. Jazz still has a place on programs especially for dancing, but it is not so noisy as it used to be and it is more melodious."

Guiding the Good Ship Radio

An Interview with W. D. Terrell, Chief Supervisor of Radio, Department of Commerce—The Radio Inspector's Relation to Broadcasting—The Amateur's Service to Radio—Elimination of Interference by Coöperation

By DWIGHT K. TRIPP

MANY people think that the amateur is a boy playing with a toy, and that he serves no useful purpose," says W. D. Terrell, Chief Supervisor of Radio, Department of Commerce. "This is a mistaken idea. The licensed amateurs of this country number in their ranks doctors, lawyers, business men, engineers, and, in fact, men and boys of all ages and of all walks of life. Many of our amateurs are men who are seriously interested in the development of radio, and the boys, through their amateur training, develop into the most successful commercial operators. As amateurs these boys learn to adjust their sets properly, make repairs, receive messages under the most difficult conditions, and become generally self-reliant. They proved their value to this country as a reserve force during the late war. As a rule, they are law-abiding, unselfish, and anxious to coöperate with our branch of the government service to the fullest possible extent. This country has long appreciated their worth and it has extended to them privileges not enjoyed by the amateur of any other country. Recently, I am glad to say, other countries have begun to take a more liberal view of their activities."

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W. D. TERRELL

Through the energies of the radio amateur, many new and wonderful discoveries have been made, among the most important of which was the discovery a short time ago that short wavelengths are more efficient than the longer ones. Through the use of wavelengths as low as three-quarters of a meter, amateurs have recently conducted two-way conversations over hitherto unheard of distances.

"The radio inspection service," says Mr. Terrell, "has done much for the amateur, by explaining that much of the interference attributed to the amateur by the broadcast listener, is, in fact, caused in some other way. Last winter, many complaints of amateur interference through the Middle West and in the Great Lakes region were received. Investigation by the inspection service disclosed the fact that nearly all of this interference was caused by commercial ship stations operating in the Atlantic Ocean and in the Gulf of Mexico. At that time, ship stations were permitted to use 666 kilocycles (450 meters) well within the broadcasting band. The situation was serious, and when it was brought to the attention of the Secretary of Commerce, a regulation was issued prohibiting the use of that wavelength by ships, assigning to them instead a wavelength of 706 meters (425 kc.)."

The first radio regulation was inaugurated in June, 1910, for the purpose of enforcing the installation of wireless equipment on certain passenger-carrying vessels. Since that time the Radio Inspection Service has developed into one of the most important branches of the Department of Commerce. Under the Act of 1910, the Secretary of Commerce and Labor organized on July 11, 1911, the Radio Service of the Bureau of Navigation. A subsequent Act, approved in 1912, stipulated that all vessels navigating the ocean or the Great Lakes and carrying fifty or more persons, including passengers and crew, be equipped with radio. An Act to Regulate Radio Communication was approved in August, 1912. Under this Act, transmitting

stations and radio operators are licensed by the Department of Commerce.

THE RADIO POLICE

JUST as Ariel, in the fables of the Middle Ages, was a spirit guardian of the air, so in this day of wireless, the Radio Inspector, a modern Ariel, stands a silent watch over the ether. But though he may be silent and, indeed, an angel, he is far from a fable, as those who attempt to dispute his wavemeter soon find out. For the Radio Inspector, ready at all times to be of assistance to those who need him, is essentially a traffic officer of the air, and to him falls the tedious duty of directing the myriad of amateur, commercial, experimental, and broadcasting stations under his jurisdiction.

"The Radio Inspector's work," Mr. Terrell continues, "enables the broadcast listener to receive programs without unnecessary interference. This is accomplished in part by the careful adjustment of broadcast transmitters to their assigned frequencies and to a constant inspection of these transmitters to insure their remaining so adjusted.

"The careful adjustment of commercial and amateur transmitters accomplishes the same results. Readjustments are necessary whenever it is found that one station is heterodyning another because of a slight change in the adjustment of the transmitter.

"Investigations of complaints of interference caused by electrical devices other than radio transmitters, such as, for instance, leaky power lines, magnetos on telephone lines, x-ray and violet-ray machines, electrical precipitation plants, and so forth, are not controlled by the present radio law, but many of such sources of interference are eliminated through coöperation.

"Radio Inspectors frequently give short talks to audiences in the cities which they visit concerning the problems which they encounter in their work, as well as the problems of the listeners-in.

AND WHAT ABOUT THE FUTURE?

THE Radio Inspection Service has helped the commercial operator to maintain a high standard of excellence by providing examinations for commercial operators which only well qualified men have been able to pass. The results have been gratifying, for in the many cases of disaster to ships at sea, not one case has been reported where the commercial operator has failed to observe the orders of the master of the vessel, has failed to show the highest courage, or has failed to remain at his post until his duties have been fully performed."

No, the task of the Radio Inspector is not an easy one nor does it promise to be easier in the future. But as for the radio future, we can safely say that it will take care of itself, for it is in exceedingly competent hands.

RADIO INSPECTION DISTRICTS OF THE UNITED STATES

Some Remarks on Audio Amplification

If You Aim at High Quality in Radio Reception, Here Are Some Suggestions on Improvement Through the Use of High Plate Voltage and a Special Use of By-Pass Condensers—A Discussion of What Occurs in the Audio Circuit

BY GEORGE C. CROM, JR.

¶ *THE search for high quality in the audio circuit of the radio receiver is growing more general and more popular every month. In the August, 1925,* RADIO BROADCAST *an article by John B. Brennan appeared describing the construction of a two-stage audio amplifier of very high quality. This article by Mr. Crom, while in no sense a construction article, contains some interesting ideas on methods for securing better quality. These suggestions, as far as we know, have not been formulated by any other writer. The Crom amplifier demands a high plate voltage, which is best supplied from alternating current and Mr. James Millen will describe an amplifier unit, practically embodying Mr. Crom's suggestions, in an early number of this magazine.*—THE EDITOR

ONE of the most common of all radio devices is the two-stage amplifier, which, common though it may be, is often not constructed or operated in the most satisfactory manner. Insufficient thought is given to each of the components and their relation to each other and this results in the production of sound in the loud speaker utterly different from that imposed on the input circuit of the audio amplifying arrangement. The faults of design are made very evident when the audio amplifier output circuit is fed to a good loud speaker of the cone type. In some instances, poor reproduction has been blamed on the speaker instead of on the audio amplifier, where it actually belongs.

THE PROBLEM OF GOOD AMPLIFIER DESIGN

AN AUDIO amplifier must be capable of raising a weak audio signal of rapidly varying frequency to the required strength without materially changing the relative value of each frequency.

It should, if it is to be an ideal amplifier, be easy to build and operate and should be low in first, and upkeep cost. The latter requirements, if the others are not to be sacrificed, are very difficult to realize.

In order to visualize the problem more completely, let us consider the functions of each part in the amplifier circuit, assuming that the tone quality being received on the detector is sufficiently good for most purposes. The small currents in the detector circuit must be fed into the primary of the transformer and converted by the transformer into a voltage variation on the grid of the first amplifying tube.

Although, perhaps, this process does not seem to be particularly difficult, it is well to remember that these small currents are composed of three entirely distinct forms. We have a direct current which is supplied by the detector B battery, a radio frequency current derived from the carrier wave of the broadcasting station, and the audio frequency current resulting from the rectifying action of the detector tube. It is this last current which we wish to amplify.

Fig. 1 shows the paths of the various currents in the detector circuit. The radio frequency or carrier current is by-passed directly to ground by the condenser placed between the plate and the negative filament terminal. The usefulness of this path is directly proportional to the size of the condenser, and if this part of the circuit were considered alone, a very large condenser would give best results. But a practical difficulty arises in that a large by-pass condenser here will also by-pass some of the audio frequencies which we wish to amplify, that is, the upper audio frequencies, approaching the lower radio frequencies. So in practice, the size of this condenser is limited by the necessity of conserving the audio frequency voltages present in the plate circuit, and sizes between .001 and .006 mfd. are generally used. The exact sizes that give best results for a particular layout are found by experiment.

The effect of the direct current in the plate circuit does not pass beyond the transformer itself, as only fluctuating current or voltage will pass through a transformer.

The audio frequency current passes through the primary, and through the large by-pass condenser (1 or 2 mfd.) back to the filament of the detector tube. This large by-pass condenser is a necessity for quality reproduction, as it prevents this audio current from flowing through the leads to the B battery and the B battery itself, and conducts it through a short path to the filament. The B battery and its leads have resistance and inductance. If the audio currents flowed through these leads, it would couple the circuit of the detector path to the plate circuits of the other tubes using the same B batteries and leads, by means of this common resistance and inductance. The majority of squeals and audio howls in an amplifier are caused by common circuits and by capacity couplings.

The audio current, in passing through the primary of the transformer, induces a voltage in the secondary by means of the magnetic flux induced in the iron core of the transformer, and this voltage is impressed between the grid and filament of the first audio tube. The plate current of the audio tube is controlled by this voltage, and variations exactly similar in form to those of the grid voltage will follow in the plate current if the operating conditions of the tube are correct.

GOOD QUALITY OF RECEPTION MEANS GOOD TRANSFORMERS

IN CHAPTER VII of *The Thermionic Vacuum Tube*, by Van der Bijl, a complete discussion of the action of the vacuum tube when used as an amplifier is given, and the reader is referred to this book for complete information, some of which is too involved or too technical for presentation in this article. Proof of most of the statements made in this article can be found by the careful reader in this book.

Before discussing operating conditions of amplifier tubes it is necessary to make one further statement about transformers. Good quality of radio reproduction—to which more attention is constantly being given—can not be obtained with cheap, poorly designed transformers. In order to obtain amplification of the lower audio frequencies, such as those of a drum or bass viol, it is necessary that the impedance of the primary winding of the audio transformers shall be, at that particular low frequency, at least two and one half times the impedance of the tube connected to the primary of the transformer. Transformers made by most of the reliable manufacturers have this necessary primary impedance.

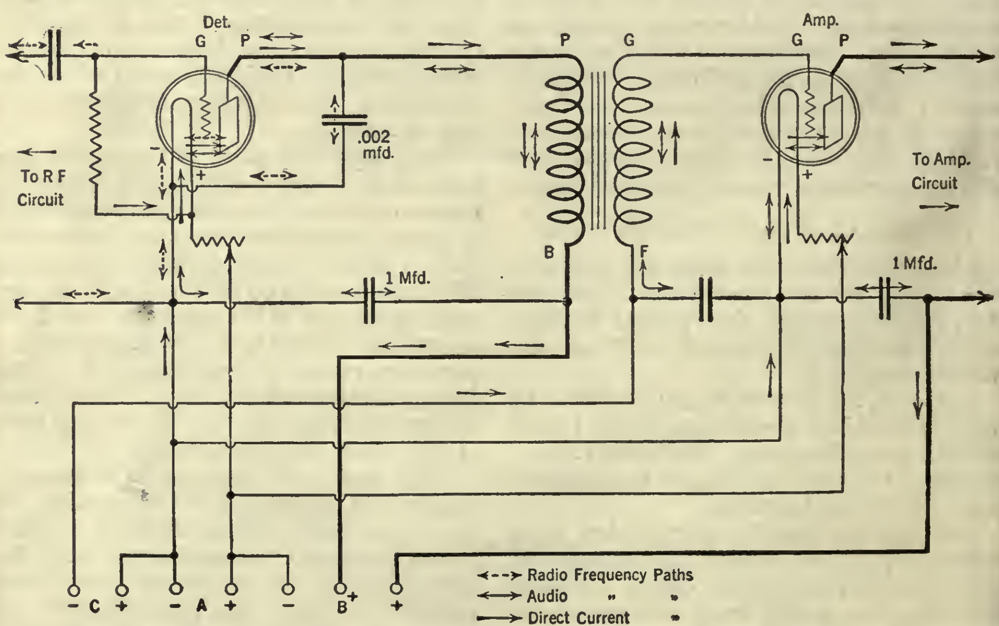


FIG. 1

The paths which must be followed by the different currents in a good audio frequency amplifier. The author tells how to keep them on the right path

DISTORTIONLESS AMPLIFIER OPERATION

THE conditions for distortionless amplification in the amplifier tube itself are as follows:

1st—The filament must be operated at a temperature high enough to supply all the electrons resulting from the sum of the direct plate current and its audio frequency component. The majority of good tubes give this necessary electron emission at low temperatures such as that resulting from 4.5 to 5.5. volts across the filament of a five-volt tube.

2nd—The plate circuit should have sufficiently high impedance. This high impedance straightens out the curve which is usually referred to as the operating characteristic, and is explained in Paragraph 60 of Van Der Bijl's book. This is too involved a discussion for this article.

3rd—The grid must be maintained negative with respect to the filament so that at the positive peaks of the signal-voltage wave, appreciable current does not flow to the grid. If current does flow to the grid, it pulls down the plate current and causes a bend in the operating characteristic curve, that is, the positive peaks of the plate current waves are cut off. As current flowing to the grid must pass through the transformer secondary with its many turns, it may saturate the transformer core, pull down its amplification and thus cause distortion in the transformer. The value of the C battery necessarily depends upon the structure of the tube used and upon the signal voltage. Most tubes can be operated one or two volts positive at the peak signal voltage. This is not necessarily true, for individual tubes vary widely.

4th—The plate voltage must be high enough so that the plate current can faithfully follow the grid voltage. The plate voltage must force the plate current through the resistance of the apparatus in the plate circuit and still apply enough voltage to the tube, so that at the maximum negative signal voltage on the grid some plate current will still be flowing. In other words, the negative peaks of the plate current waves must not be cut off.

These conditions sound complicated but they are not when stated simply. The first is: use good tubes and keep your A battery charged. The second is: Use good transformers. The third and fourth are: Use the proper value of C battery for the signal voltage at the grid of each tube, and the plate voltage which corresponds to this C voltage.

One way to check up on these last two conditions, is to measure the signal voltage at the grid of each tube with a vacuum tube voltmeter, which measures peak voltages, and use the value of the voltage measured as the amount of the C battery voltage, and increase the plate voltage to the value given by the tube manufacturers for this C voltage. This is

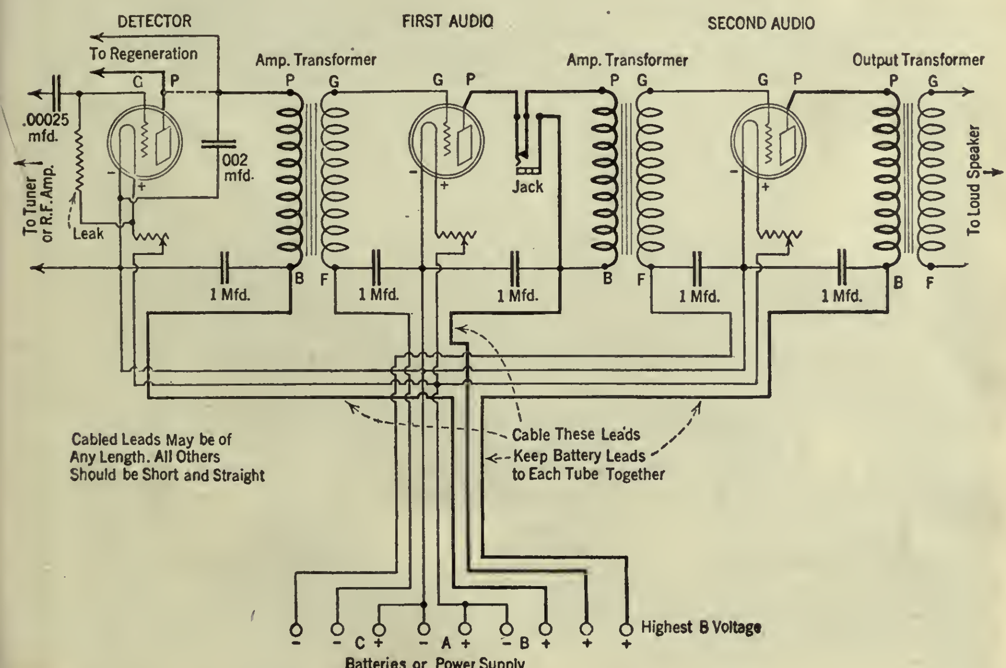
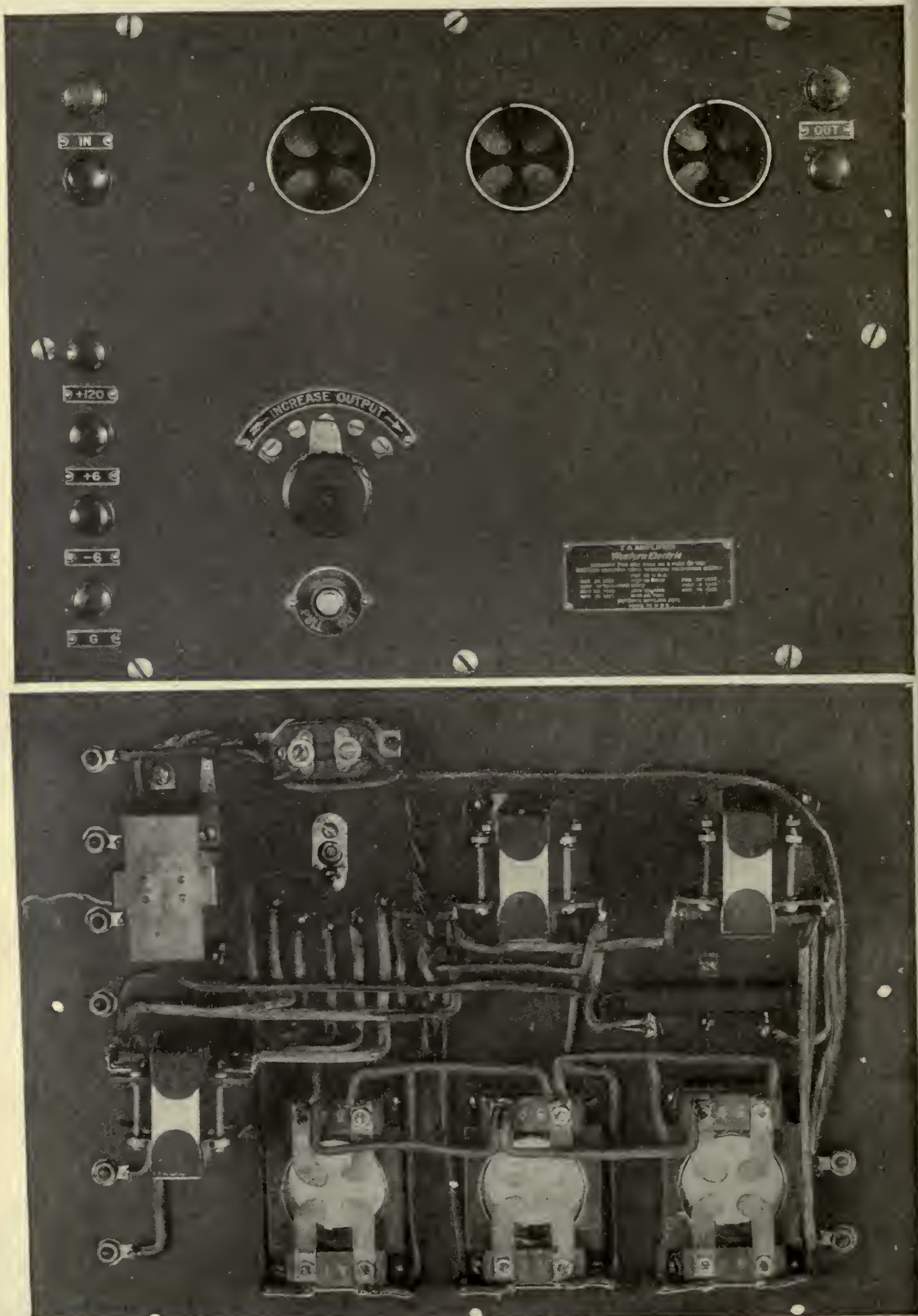


FIG. 2

The circuit diagram of a high quality audio frequency amplifier. Note in particular the output transformer, by-pass condensers, and cabled leads



AN EARLY TYPE OF HIGH QUALITY PUSH PULL AMPLIFIER

A front and rear view of one of the first high quality amplifiers to be put on the market. It is of the push-pull type, and made by the Western Electric Company

beyond the usual fan, because vacuum tube voltmeters are expensive and scarce.

The most satisfactory method, and also the easiest, of determining these last two conditions is to put a milliammeter (d. c. of, say, 0–15 milliamperes) in the plate of the amplifier tube under investigation and observe the plate current, while the strongest signal that is to be received, is going through the amplifier. If the C battery voltage is not high enough and positive peaks of the plate current are cut off (and current is flowing in the grid circuit), the plate current will decrease with a strong signal. Increasing the C battery will prevent the grid going too much positive.

If the plate voltage is too low (in the opinion of the writer, it usually is) and the negative peaks of the plate current are being cut off, the current will rise on a strong signal. Increasing the plate voltage will remove this difficulty.

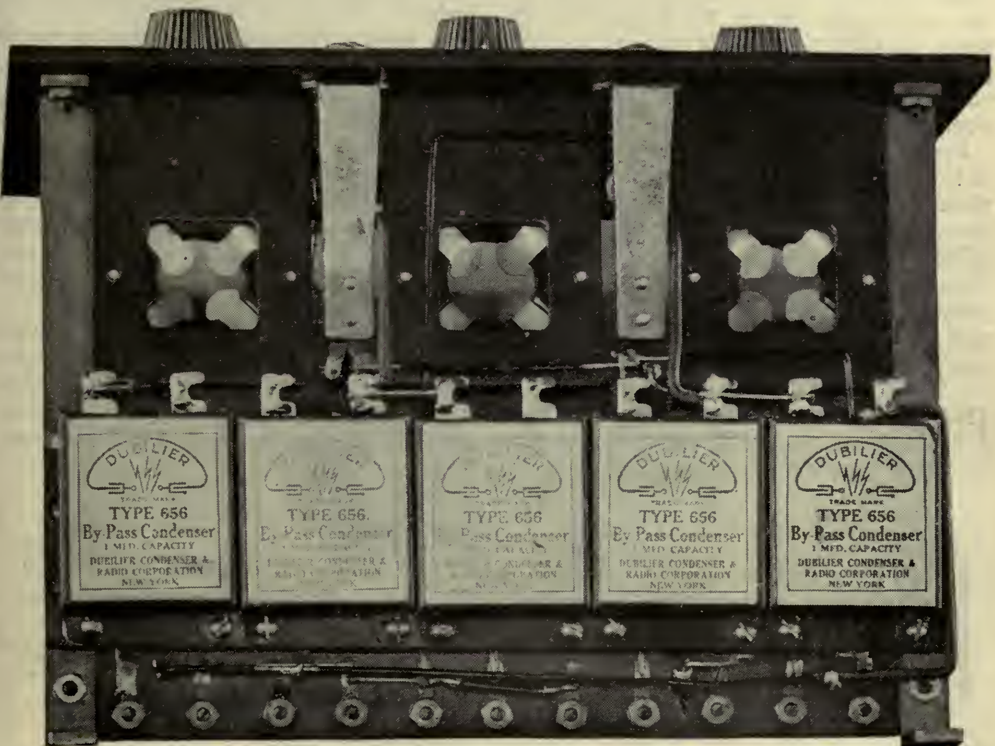
Both of these effects may be, and often are, present at the same time so the needle of the milliammeter may fluctuate violently.

For quality amplification, the plate current should not vary, so it is necessary to increase the C battery and the plate battery, until there is no appreciable variation of the plate current of each tube on the strongest signal that will be received. Most of the better grade filament voltmeters now on the market can be used as milliammeters as they usually have a full scale deflection for about 15 mA. The milliammeter (or filament voltmeter) can be best put in the lead to the B battery near the battery where its capacity will have no effect on the operation of the amplifier.

CHECKING THE CIRCUIT FOR QUALITY

AFTER the first stage amplifier is checked up in this manner, the same method may be applied to the second stage. It is easily seen that the signal voltage on the grid of the second stage will be higher than that on the first, so it is necessary that the C battery voltage applied to the second amplifier should be higher than on the first and its plate voltage should be correspondingly higher. The milliammeter test will show by its fluctuations if these voltages are not right.

The signal voltage on the grid of each am-



IMPROVING QUALITY IN A TWO-STAGE AMPLIFIER
How by-pass condensers whose value is suggested in this article, may be added to the Quality Amplifier described by Mr. Brennan in the August Radio Broadcast

plifier tube determines the amount of C battery to be used. The signal voltage and the C battery voltage fix the plate voltage required. The C battery voltage and B battery voltage can be higher than necessary but cannot be lower, without overloading the grid of the tube and causing distortion in the tube itself.

The average receiving set, regenerative or neutrodyne, or other circuits of equal merit, require much higher C and B voltages on the first and especially on the second stage, than are usually supplied.

A large number of tests have shown that these voltages should be, depending on signal voltage, tubes, and transformers:

1st-Stage	C-4.5-9 Volts	B-90-120 Volts
2nd- "	C-12-30 Volts	B-200-450 Volts

Where plate voltages such as these last values are not available or are not desired for economic reasons, even though the second audio tube is overloaded, the signal voltage can be decreased by using a low ratio transformer, or by putting a grid leak of less than one tenth of a megohm across the secondary. A push-pull amplifier allows appreciable distortion in each half of the circuit, but as the two audio currents are 180 degrees out of phase, the distortion cancels out; so the push-pull amplifier can be used with a limited plate voltage to give amplification without distortion.

Perhaps the best way to obtain good quality is to obtain the required B voltage from a plate supply system operated from the a. c. electric light socket. Such a system permits using a 5-watt tube in the last stage, as its filament may be operated from the same transformer that supplies the plate power. But that is another story.

A SUGGESTED HIGH-QUALITY AMPLIFIER

IN FIG. 2, a diagram of a two-stage amplifier is shown. Attention is called to the way in which by-pass condensers are used to shorten the audio frequency paths, and to keep these frequencies in their separate circuits. Also note the way in which all the battery leads are grouped closely together in a cable, thus avoiding closed loops, which might cause coupling between stages. Grid and plate leads should be kept short and straight. The leads to the by-pass condenser should also be kept short as they are part of the audio circuit.

More than two audio stages are unnecessary except where more than one loud speaker is to be operated. Two well built audio stages, with proper grid and plate voltages, will operate two cone type loud-speakers so that they may be heard for several blocks without distortion.

The general purpose five-volt tubes will hold up under continuous operation at plate voltages of 250 to 300 with a C battery of 16 to 22 volts. Sometimes, however, it is necessary to pick out of several tubes, the one which will stand up best under this load. Several of one make of five-volt tubes were operated for six months with 350 volts on the plate and were still going strong when the test was ended.

In using such high plate voltages on the last stage it is essential that the direct plate current be kept out of the loud speaker. This can be done either by using an output transformer, or by using a choke coil of 75 to 100 henries. in the plate circuit with a condenser of two to six mfd. between the loud speaker and the plate. The audio current will pass through the condenser to the loud speaker and then return to the filament, while the d. c. passes through the choke coil to the battery.

Now that good loud speakers (such as the cone type) are available, and broadcasting stations are transmitting signals of high quality, distortion of the signal in radio receivers is absolutely unnecessary, and can and should be prevented.

The Listeners' Point of View
Conducted by Kingsley Welles

Do We Need "Silent Nights" for Radio Stations?

THOSE two letters "DX" have caused as much radio joy and sorrow as any others known in the vast and mystic terminology of the science. To radio widows, the term is anathema; to radio fans, it represents a high form of enjoyment. To build or buy a set which will bring in the call letters of some broadcaster two or three thousand miles removed is better than being elected to Tammany Hall, or fathering the prize baby in the annual exhibition at Atlantic City. Those captious souls who sneer at radio like to say that broadcast listeners have installed their radio merely to indulge this passion for distance.

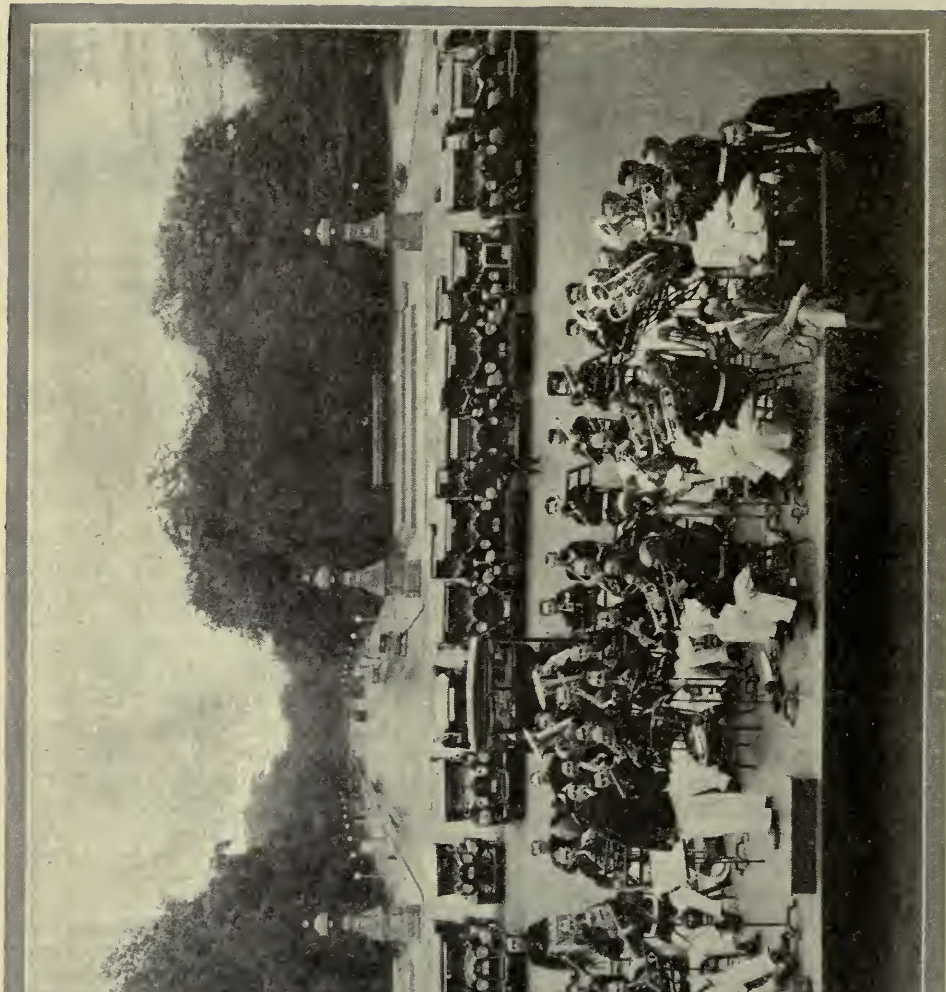
Well, that portion of the radio audience whose religion is DX come by that honestly. The very terms comes from the vocabulary of the intent amateur whose constant lust has been to project signals from his own little transmitter to some listener equally intent a great distance away. In the prehistoric wireless times of about 1909, his cup of joy fairly bubbled if reports of reception came from a paltry twenty miles. Now your amateur speaks calmly of communication with Australia. The alluring possibility of being able to send signals six or seven thousand miles is the chief force which makes the experimenter an "amateur" and keeps him up indecently late o' nights.

And a very large body of radio broadcast listeners, who differ very little essentially from the "transmitting amateurs," gain their chief pleasures from searching out the elusive carrier wave of a broadcaster terrifically far away. The publicity writer for station KFI, Los Angeles, has put the lure well:

> For the Atlantic Coast to hear the Pacific Coast or vice versa is to journey into the unknown and come back with a new lease on life. DX is the home run, the hole-in-one, the six-pound trout, the twelve-point buck, the royal flush of the radio game, and those who seek to discourage it are striking at the very well-springs of the go-getting national spirit. Earle C. Anthony says, "Let the DX'er take for his motto, 'We will fight it out along these lines if it takes all summer', and continue to burn the midnight tubes. After all, who wants to tune-in when you can see the whites of their eyes?"

OLIVER SAYLER

Who presents, through WGBS, New York, one of the most interesting features given by any broadcasting station in his talk every Thursday evening at 8:30 called "Footlight and Lamplight." Mr. Sayler never fails to bring his listeners something worth hearing



THE UNITED STATES MARINE BAND

Captain William H. Santlemann, conducting, playing one of two weekly concerts which are broadcast by WRC, WJZ, and WGY. The band is shown on the special platform erected in front of the steps of the Capitol building at Washington. The audience is seated in motor cars nearby and on the steps of the Capitol. Norman Brokenshire, whose excellent announcing is familiar to radio listeners in the East, is seated at the left of the control apparatus

CONDUCTORS OF THE NEW YORK PHILHARMONIC ORCHESTRA

Whose programs have been beautifully transmitted by WJZ, WGY, and WRC. At the left is Rudolph Ganz, conductor of the St. Louis Symphony Orchestra. In the upper center circle is Nikolai Sokoloff, conductor of the Cleveland Symphony Orchestra. Fritz Reiner (right) is the conductor of the Cincinnati Symphony Orchestra. In the lower circle, center, is Willem Van Hoogstraten, conductor of the New York Philharmonic Orchestra. Mr. Ganz, Mr. Sokoloff, and Mr. Reiner were invited to act as guest conductors of the Orchestra

This ether fishing is no chore for the listener located at a moderate distance from stations of large power. But for the unfortunates in large cities where broadcasters keep their tubes glowing from the setting-up exercises in the morning until the last dance orchestra has folded up its drums and silently stolen away, the job is not so easy. No matter how selective a receiver is, it is hard to get through the strong waves of the locals and to hear the elusive DX broadcaster.

By a kind of gentleman's agreement during the past year, Chicago broadcasters have kept off the air on Monday nights to allow the natives to indulge their urge for distance. Lately, the news has quietly leaked out through the medium of the Associated Press that there is dissention among the broadcasters in the Chicago area and the listeners in same. Those broadcasters who have studios in Chicago and transmitters in the suburbs feel, it seems, that since they are not local in a very strict interpretation of the word, there is no reason why they should keep to the silence agreement. So the local stations have been silent on Monday nights and the suburban transmitters have been whacking away at the ether.

Mr. Frank H. McDonald, president of the Broadcast Listener's Association, has announced that a canvass of radio listeners in Chicago shows that 98 per cent. of the canvassed listeners are in favor of a silent night. He further says his Association is planning to have a bill submitted to the next Congress which would divide the country into six radio areas and assign a different quiet night to each. Sunday, according to this proposal, would be open night.

Mr. McDonald's Chicago broadcast listeners are doing well to organize in order to express their opinions, but the mere fact that a large and powerful Chicago group want to indulge in DX fishing is no reason for making national silent nights legally compulsory on the entire country. We have no quarrel with DX hunting, or with the silent night idea, but the matter is manifestly one for local option.

One cannot help but suspect that, when there is so strong a demand from listeners to hear programs from other localities, there are

serious lacks in the local programs. There has never been, in the New York area, for example, any similar widespread desire for a silent night. If one judge the signs in that territory aright, in the main, the local programs have proved quite satisfactory for every taste. And since WEAF has linked itself through the long lines of the Bell system regularly to representative stations in the East and Middle West, programs of the highest quality and of great variety of appeal have been made available to a larger number of listeners than ever before.

We might as well call things by their right names. If radio is really entertainment, then the program is the important thing. If that is true, the source matters less than, in a manner of speaking, the bone and sinew of the program itself. But, on the other hand, if radio reception is a kind of elaborate animated geography lesson, then every effort ought to be bent to give those devotees the chance to hear distant names whisked through the microphone.

Brooms for Symphonies

YOU excellent folk who live in civilization don't know and can't realize what a wonder first-rate broadcasting is to those who live in distant places. Oh yes, we are civilized—we have in some homes modern plumbing, and electric lights in most, and that's more than Bach ever had or dreamed of. We have stations of our own which do their best . . . with *n*th rate singers (why *will* they sing?). But perhaps it is unkind to look at gift horses.

COUNT ALEXANDER SKRZNSKI

Foreign Minister who spoke recently over WEAF and a chain of eight others. His address came at the end of an excellent hour of Polish music. When the WEAF announcer described the program, he made the startling statement that Count Skrznski would be "accompanied by a Polish orchestra"

"Last night," continues Mr. P. H. Russell, of Red Deer, Alberta, from whose recent letter we have taken the liberty to quote, "I turned the switch on my home-made Haynes super-heterodyne, and was more than thrilled to hear faintly through the midsummer heat—you'd not guess unless you heard it—Bach's double sonata!"

> This is a small place. There are 2400 people of all ages, sizes, conditions, and sorts. There is one pianist who is such, and is a sort of prodigy. He is good, too. There are also one or two others who don't know anything about music but who know what they like. So you will gather that the standard is high for a town in the wilds. Sitting with me were the top local fraulein and a friend, appointed masculine associate for the nonce, smoking cigarettes with me.
>
> My office has a forgery of George Clausen on the wall, and a Raeburn copy, and a print of Praxiteles' "Hypnos." My walls are covered with books ranging from Gibbon's *Decline and Fall* to detective stories. There are a few law books, of course. So I can smoke cigarettes with the stenographer freely (when no Methodists infest with their accustomed severity.)

"Believe me," continues Mr. Russell, "when that music came winding in, a wonderful, faint thread of beauty, then a latter-day (and really rather charming) flapper and her youth, a railway fireman, ceased from talking and listened. They didn't say so, but I knew, for they looked it—they had never heard anything like it before. Then the thread faded into mutterings of static and I never heard whence it came. But it sounded like the music of the spheres."

Those stranded souls who live in the territory rather vulgarly called the sticks depend much on what the broadcasters offer, and how much more worth while radio must make life! Fortunate are those rural inhabitants who like jazz and non-musical programs of like level. For radio stations are really making the ether one huge vaudeville performance, with the emphasis on ultra-popular music, quite in the manner of the variety theatre. All stations, with the exception of those operated by religious organizations, are trying to be all things to all men. Here a child prodigy on the violin, there a famous boxer, giving his opinions on how to become a famous boxer; a politician casting pearls of partisan wisdom; an actress

whispering secrets of temporary beauty; a returned traveler confiding the curious customs of the Senegambians; and jazz orchestras, jazz orchestras, and jazz orchestras.

The impression of many listeners that radio programs are too much devoted to jazz is heightened by the fact that of necessity, all distance reception is carried on at night and everybody knows that the later evening slices of programs are invariably devoted to the local currently popular jazz orchestra.

Not even the most rabid demanders and defenders of jazz hardly insist on a steady radio diet of it. And those listeners who are in range of the Bell System wire tie-up who can hear the "pop" concerts, the Eveready Hour, the Goldman Band, and the WEAF opera company, have the opportunity to hear good music, played as it should be played. These are some breaks in what some months ago appeared to be an endless evening radio barrage of jazz. Considering this purview to beonly moderately accurate, one can sympathize with Mr. Russell's concluding plea: "Tell the broadcaster, to feed us provincials Bach, Beethoven, and Brahms, then Mozart and—but you know them all as well as I used to when I lived in London. That seems ninety years ago. Won't you give me a job sweeping your office, so that I can hear a symphony concert now and then?"

The Popular Dinner Concert

THE dinner concert has come to be one of the most popular of radio features. The term is rather inclusive, for while many of the concerts are produced by musical organizations innocent of any saxophone and associated evils, not a few are out and out dance orchestras. The best dinner music on the radio is that furnished through WEAF by Joseph Knecht's Waldorf Astoria Rose Room orchestra and the Commodore Hotel concerts from WJZ. The Benjamin Franklin Hotel

THE "HOOT OWLS" OF KGW, AT PORTLAND OREGON

A popular organization heard frequently from the Portland *Oregonian* station. The members are business and professional men of the vicinity and their breezy entertainment is eagerly tuned-for, out where the West *is*. Left to right, Ashley C. Dixon, himself a broadcaster (KFJR); Allen Greeb; R. G. Calvert, Grand Skidoo; Charles F. Berg, Grand Screech; Henry W. Metzger, Grand Slam; Barnett Goldstein, Grand Schmoos; Tige Reynolds (cartoonist of the *Oregonian*), Grand Sketch; Frank J. Sardam, Grand Scream; and William R. Boon, Grand Skipano, at the piano

Concert orchestra, heard through WIP, Philadelphia is also deservedly popular. KHJ, Los Angeles, occasionally sends out the excellent concert orchestra of Art Hickman, playing at the Biltmore Hotel. The dinner organ recitals, played by Phyllis Griswold at the Rialto Theatre and broadcast through WOAW, Omaha are worth hearing, as well.

In Cleveland, WTAM frequently offers the popular music played by the Golden Pheasant orchestra. At WWJ, in Detroit, they have the curious custom of alternating selections played by a dance orchestra with classical music by an instrumental trio. The effect is highly disconcerting when one hears an old classical favorite immediately followed by "Collegiate," or "Don't Bring Lulu." That WWJ dinner program assures one that the wise individual who, in the dim rhetorical past, asserted that it was impossible to be both flesh and good red herring, had a great weight of truth on his side. There is something radically wrong with the microphone placing at WWJ's pick-up at the Hotel Statler, because the harp in the instrumental trio comes through like the fabled falling bricks, while the piano and violin do their best to form a melodic background.

The dinner programs from WTAM, Cleveland, WCX, and WWJ, Detroit are also distinguished by a glaring, and what should be an unnecessary fault in broadcasting—that of long pauses between individual numbers. One can almost progress from the soup to the salad course during some of the Detroit program hiatuses.

JOE NOVAK

Giving one of his weekly lessons on golf from KGO, Oakland, California. Mr. Novak is a professional golfer and instructor and goes on the air at KGO, at 7:15, Pacific Coast Time every Thursday evening

Station KSD's Fine Record

STATION KSD, of the St. Louis *Post-Dispatch* has long held its place among the best of our broadcasters. On June 26, 1925, the station celebrated its third anniversary, and a review of its activities show that its programs entitle it to the high esteem it has gained. During the three years, 1434 programs have been arranged, and 1383 individuals took part. The artists represented fifteen different nationalities, twenty-five states of the Union, and 115 cities of the United States. During the three-year period, 379 pianists and 310 vocalists appeared on their programs. There were also 71 children who appeared before the microphone, and a distressing total of 41 readers. The large number of the latter strikes us as curious, because radio listeners seem to be united in their dislike of readers.

The address of the late President Warren Harding was broadcast when he spoke at the St. Louis Coliseum on June 21, 1923. This was the first time that the voice of a President of the United States had been broadcast. KSD has broadcast practically all of the important national radio political and non-political addresses which have been sent out over the long lines of the A. T. & T. Company.

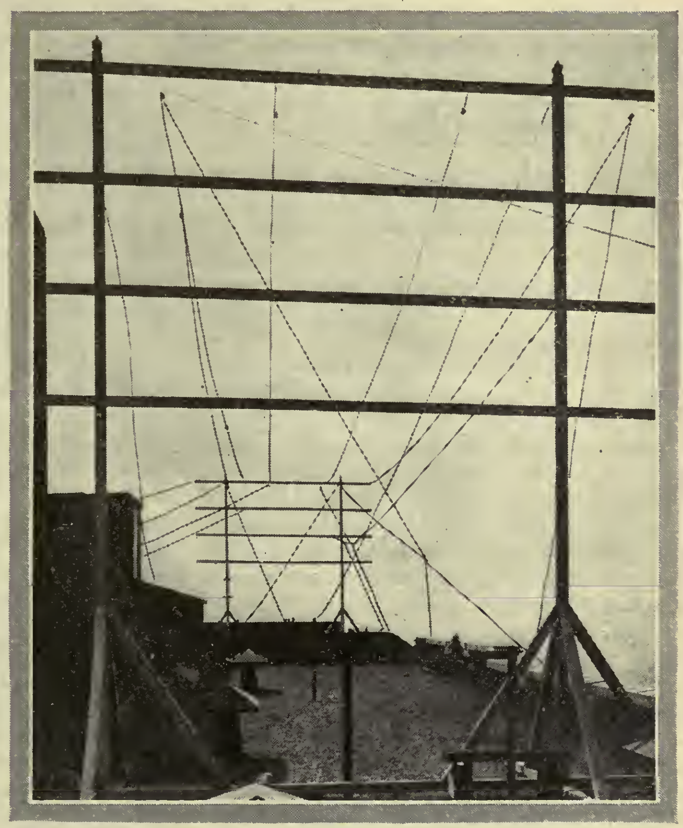
During the first International radio broadcast tests, KSD was reported by a representative number of listeners in England. The station is under the capable direction of Miss V. A. L. Jones. One wishes the station, in that good old fashion of speaking, a long life and a merry.

Reading of Applause Telegrams is Unnecessary

BY THE time this number of the magazine is published, station WJR of the Jewett Phonograph and Radio Company at Pontiac, Michigan, will be on the air with 1500 watts, transmitting at a fre-

quency of 579.9 kilocycles (517 meters). Corley W. Kirby, formerly director of station WWJ, of Detroit, is the director of the new station, and if he succeeds as well with his new charge as he did with the old, station WJR will leap into immediate favor. WWJ was licensed in September, 1921, which makes it the first American broadcaster. Mr. Kirby was associated with the station during its pioneering days.

Telegrams and greetings directed to WJR will not be read or acknowledged over the air during the inaugural program or later on, Mr. Edward H. Jewett, president of the operating company announces. He goes on, to say very sensibly: "Telegrams and greetings do not entertain those who are listening. They please only those persons who are mentioned in them. We want WJR to please the public, not ourselves."



A RADIO APARTMENT IN SEATTLE

A picture of the roof of the Biltmore Apartments in that city. Provision has been made for twenty-four antennas—one for each apartment. The owner and architect, Mr. Stephen Berg, is an enthusiastic radio devotee himself. The local KFOA supplies the tenants with much of their radio enjoyment, but distant stations are heard as well

The number of first-class stations who read telegrams, whether they be from listeners in the next block or half way across the continent, is pleasantly small. No listener should be discouraged from sending his telegrams of appreciation to a station whose offerings please him. But it is hard to find an excuse for reading them over the air. And, we might add, the listener who feels a deep throb at hearing these telegrams read is probably the same person, who, in the cruder electrical days, spent much time in listening-in on party lines.

The WGBS Prize Play Contest

NANCY BANCROFT BROSIUS of Cleveland, Ohio, won the $75 prize in the radio play contest conducted by station WGBS, New York in conjunction with WIP, Philadelphia and WGY, Schenectady. Hers was a one-act play entitled *Sue 'Em.* The play will be produced on the air through the three stations by the well known Provincetown Players of New York. Mr. Oliver Sayler, in making the announcement from WGBS during his charming "Footlight and Lamplight" period on a recent Thursday evening, said:

> The most frequent fault which the judges found among the manuscripts was a failure to remember that radio drama, unlike good little children, is heard but not seen. A number of plays were submitted which might interest a Little Theatre, but the dependence on the eye was too great. Still another fault which was frequently encountered was the choice of a subject so fantastic that all the methods by which illusion is gained in an actual theatre would be necessary to make the play convincing.

Good plays are becoming more frequent over the air. Station WGY has produced a number of Mr. Cosmo Hamilton's plays which have rightly met with enthusiastic approval. KOA and KGO have also been active with plays dur-

ing the summer months. Elliott Nugent's *Kempy* was recently produced by KGO with great success.

Broadcast Miscellany

THE Sunday evening programs of WJZ and WGY are of unusually high standard The Lakewood Farm Inn Ensemble, a Joseph Knecht group, led by Mr. Jan Weber, furnishes the first part of the program—from 7:45 to 9, Eastern Summer Time—and the delightful solo work of Godfrey Ludlow, violinist, the second half, which continues from 9 until 10. The Lakewood Farm Inn Ensemble never fails to present a program of varied interest, and their work shows that good music need not necessarily be boring or "high brow"—frightful term. Godfrey Ludlow, the staff violinist of WJZ, is an artist of very much more than ordinary talent and those in reach of the radio emanations of WGY and WJZ are missing a delightful feature if they do not hear his recitals. The accompanying verbal program notes of Mr. Milton J. Cross, the veteran announcer of WJZ are well presented, informative, and in excellent taste.

AND now to chronicle the temporary passing of "Roxy," the impressario of the Capitol Theatre, New York, whose Sunday evening programs are heard over WEAF, WEEI, WJAR, WCAP, WCTS, WCAE, and WWJ. Mr. Rothafel will have a theatre of his own in New York and has severed connections with the Capitol, but the Capitol programs will continue as before with Major Edward Bowes, managing director of the Theatre, in charge. The "Gang" —excellent group of musicians that they are—are maintaining the standard of their programs quite as before. The musical quality of this very popular feature we have never questioned, but it must be admitted that the drooling sentimentality of the presentation spoils what would otherwise be an almost perfect program of its type. Mr. Rothafel deserves much credit for devising a genuinely new type of radio presentation, but why that presentation had to be constantly weighted with expressions of almost tearful sentiment and side remarks which somehow are invariably weightily saccharine—we could never understand.

STANLEY W. BARNETT, known to WOC listeners as "BWS" has resigned his post as chief announcer at that station to assume similar duties at a new station now under construction at Baltimore, Maryland. His place at WOC will be taken by L. E. Wass, a native of Davenport, Iowa.

OVER at WJZ, New York, they have started a feature which is great delight to a large number of invalids and those afflicted with blindness. At 4:10 P. M., Eastern Summer Time, J. B. Daniel, a staff announcer, reads short stories, novels, works of history, and general selections from good literature. It is dangerously near a bromide to say that radio has taken an almost irreplaceable part in the lives of those who are shut in. Radio stations receive more mail from persons who can not actively join in the life of the world than from any others. This feature could well be adopted by many other stations who desire to expand their field of service.

ON AUGUST first, there were 561 broadcasting stations in the United States, ten less than on July first, 1925. WEAF, New York, is now using 5000 watts, and WORD, Batavia, Illinois is now operating on 5000 watts. Among the long range stations, WGY has been testing recently with 50,000 watts, chiefly after midnight. WJZ expects to have 40,000 watts "in the air" about the time this magazine appears, although unexpected delays may retard this date a week or so more. KGO, Oakland, California is now using 3000 watts, WBBM, Chiacgo, and WTAS, Elgin, Illinois are using 1500 watts. In England, the Daventry station of the British Broadcasting Company (5XX) is now transmitting on a frequency of 187.4 kilocycles (1600 meters), using 15,000 watts (7500 watts, American rating), which brings the total of British stations to 22, of which eight are relay stations. 5XX should be heard in this country by listeners whose receivers can tune to that frequency. . . . Among those broadcasters gracefully retiring from the field are WDM, Church of the Covenant, Washington, D. C.; WWAO, Michigan College of Mines, at Houghton; WVAY, The Milwaukee Civic Broadcasting Station, Milwaukee, Wisconsin, and WRAA, The Rice Institute, Houston, Texas.

In Which Some Discrepancies Are Cleared Up

Some Interesting Correspondence Relating to an Article by E. T. Flewelling in Our Friendly Contemporary, *Radio in the Home*

WE WERE surprised to find in the July number of our contemporary *Radio in the Home*, for which we have had a lot of respect, an article by E. T. Flewelling, one of the Associate Editors, in which a very severe criticism of a circuit appearing in RADIO BROADCAST for June was made. The attack was made on the Frequency-Changer or Super-Heterodyne Converter described by Mr. A. O'Connor of Cleveland, Ohio.

The various letters passing between Mr. O'Connor and the Editor of *Radio in the Home*, as well as our own office, point out quite clearly that we were perfectly justified in bringing the Frequency-Changer to the attention of our readers.

It did violence to some of our ideals of professional ethics to find that the Associate Editors of *Radio in the Home* find it advisable to criticise the technical articles appearing in RADIO BROADCAST. Some of our old readers will remember that Kenneth Harkness' first claim to fame came as a result of the publicity he received in connection with the single-tube reflex receiver described in RADIO BROADCAST in November, 1923. Following his connection with *Radio in the Home*, Mr. Harkness maintained, in an article appearing in that magazine, that resistance-coupled amplification was of no practical value. He seemed to forget that one of the principal objections to resistance-coupling had been overcome when the dry cell tube and the quarter-ampere storage battery tube had been developed. If there are any among our readers who have a notion that resistance-coupling is not worth while, we shall be delighted to demonstrate a resistance-coupled receiver for their benefit at any time they would like to visit our laboratory.

The situation with regard to the O'Connor Frequency-Changer may well be understood by reading the letters which follows:

June, 26 1925.

Mr. Henry M. Neely,
℅ Henry M. Neely Pub. Co.,
608 Chestnut St.,
Philadelphia, Pa.

DEAR SIR:

The writer has just read with a great deal of interest the article entitled "Why Not a Super-Het Converter" in July issue of *Radio in the Home*. Your "word of explanation" was particularly interesting.

I am glad to see that Mr. Flewelling was finally clever enough to "tackle it right" and got the circuit working. He may be interested in knowing that numerous BCL's have had wonderful success with the circuit in June RADIO BROADCAST, (to which he referred.)

The writer has read your magazine from the beginning with a great deal of interest and while not always agreeing with you, has admired you for having the courage of your convictions. I am, however, very much surprised in this issue to notice that your magazine allows a direct slam at such a high class magazine as RADIO BROADCAST. Mr. Flewelling by this time should know that RADIO BROADCAST will not publish a circuit until they are absolutely sure that it is correct. I don't think that Mr. Arthur Lynch is going to like Mr. Flewelling's remarks in your "word of explanation."

Very truly yours,
A. O'CONNOR.

June 30, 1925.

Mr. A. O'Connor,
9702 Euclid Ave.,
Cleveland, Ohio.

DEAR MR. O'CONNOR:

It was with something like a shock that I learned from your letter of June 26th that the magazine to which Mr. Flewelling made unfavorable reference was RADIO BROADCAST. I thought at the time of publication that the magazine was . . . . and that is why I let the Flewelling remarks go as they were. If I had known that they referred to RADIO BROADCAST, I should not have printed them because I can assure you that no one in the whole radio field has a higher respect for RADIO BROADCAST nor a greater personal liking for Arthur Lynch, Editor, than I have.

Yours very truly,
HENRY M. NEELY.

July 7, 1925.

Mr. H. M. Neely, Editor,
Radio in the Home,
608 Chestnut St.,
Philadelphia, Pa.

DEAR FRIEND NEELY:

A few months ago you took RADIO BROADCAST for a rather severe ride concerning resistance-coupled amplification, and Kenneth Harkness, one of your Associate Editors, said that resistance-coupling should never have been taken from the grave in which it was peacefully reposing, or words to that effect. I cannot refrain from putting you on the pan this morning for a little roasting and trust that you will take what I have to say in good part, as I know you will.

On page 14 of the July, 1925, number of *Radio in the Home* we find a rather interesting disserta-

tion by Flewelling on "Why Not a Super-Het Converter?" Among other things Mr. Flewelling says: "In discussing the subject with H. M. N., I started a line of thought that appealed somewhat to both of us as one that should prove of very great value to the public as a whole so far as its selectivity problems are concerned. The thought is not entirely new, because more than one engineer has probably given time to it, but, so far as we know, it has never been given to the public."

In the editorial box accompanying this article we find the following statement also credited to Mr. Flewelling: "The Super-Het converter is working great. I see that another magazine hit at it in their June issue. The thing doesn't work, however. I know several good men who have tried it and found it a dud."

With regard to the first statement that the super-het converter is not entirely new, Mr. Flewelling is entirely right. A similar idea was described by George J. Eltz, Jr., in Radio Broadcast for December, 1923, and another arrangement of the same general character was described by Zeh Bouck in Radio Broadcast Lab Department for January, 1924. A wave-changer described by Mr. A. O'Connor employing the same principle was published in Radio Broadcast for June, 1925, and it is evident from what Mr. Flewelling has said that it is our frequency-changer which has been characterized by him as a dud since we have not been able to discover an article on the frequency changer in any of the other periodicals in their June number.

Mr. Flewelling is wrong, impossible as that may seem. The O'Connor wave-changer is anything but a dud. We have used it in our laboratory for months and have tried it in connection with all kinds of receivers. It works in an extremely satisfactory fashion and we know definitely that a great many readers of Radio Broadcast have built this Frequency-Changer and are finding that it works as well for them as it does for us.

Now, we don't mind having somebody grab off our ideas, and put a new face on them and call them new, but we do hate to have our competitors publish statements which in themselves are untrue—and the statement that our frequency-changer is a dud is untrue—and if you don't think so, come over to Garden City and I will be delighted to show you how well it works. In fact, I will go further than that if you think it is necessary, and drop in at your own laboratory with the Frequency-Changer under my arm.

We, as you know, are trying to do a good job on Radio Broadcast and we feel sure that you are attempting the same thing in your field. We feel that the attack on our technical accuracy is entirely uncalled for, and in this instance, entirely unjust. We believe that in fairness to us, a statement from you and one from Mr. Flewelling appearing in your paper concerning the O'Connor Frequency-Changer described by us should be made.

I have not overlooked your magnaminity in proclaiming Radio Broadcast's Roberts Knockout the most popular circuit of the season. And for this statement I am duly grateful.

Cordially yours,
Arthur H. Lynch, *Editor*,
Radio Broadcast

July 29, 1925.

Mr. Arthur H. Lynch, *Editor*
Radio Broadcast,
Doubleday, Page & Company,
Garden City, N. Y.

Dear Arthur:

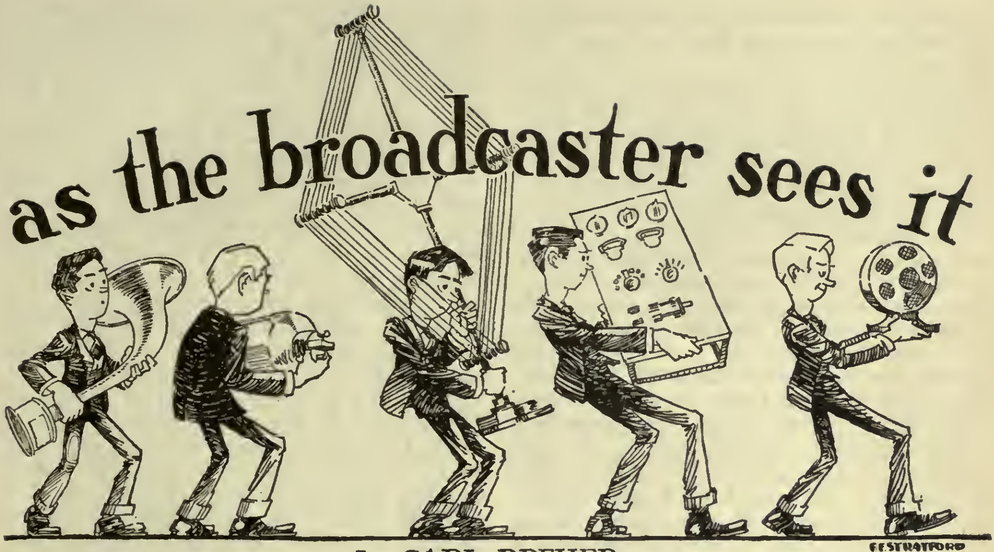
As I told you during the chat we had at Atlantic City, I am extremely sorry that the attack made by Flewelling on your Frequency-Changer should ever have been made, and I am equally to blame for having published it without having made a thorough investigation.

It was an error, and you may be sure we will make every effort to coöperate with you in repairing any damage it may have done.

Cordially yours,
Henry M. Neely, *Editor*,
Radio in the Home.

The letter above is characteristically a Neely letter. Mr. Neely is broad-minded enough and honest enough to admit a mistake and make every effort to try to rectify it. Which should close the subject.

A COMPLETE receiver has been designed by Radio Broadcast with two aims in view—high quality in the audio side of the circuit, and operation of the audio amplifier tube, and the plate supply of the radio, detector, and first audio tube directly from the alternating current house supply. The receiver circuit is a tried and true design. Overloading—that general fault in audio circuits is avoided by the use of a power tube, entirely operated from a. c. This receiver for home construction will arouse a great deal of interest because it takes the lead in current receiver design—a sensitive circuit, used with an audio amplifier whose quality is irreproachable. An article fully describing this receiver will appear in an early number.



by CARL DREHER

Drawings by Franklyn F. Stratford

A Debate: Resolved, That 500-Watt Stations Are Not Sufficient for Program Service

Affirmative: Mr. Dreher *Negative:* Professor Williams, WHAZ

REGULAR readers of this department will recall that Mr. Dreher took exception to statements made by Professor Williams of Rensselaer Polytechnic Institute in a recent address at Hartford. Professor Williams contended, in brief, that the proposal to permit the operation of long range broadcasting stations was technically unnecessary and that the familiar 500-watt broadcaster produced a satisfactory signal under most conditions. Mr. Dreher particularly took exceptions to Professor Williams' remarks about power level. Professor Williams has been good enough to amplify his ideas and they, together with Mr. Dreher's reply, are printed below. The subject is important, for it concerns every broadcaster and every broadcast listener. Intelligent discussion of the subject can do a great deal to clarify opinion on this much-discussed question of "super-power" and we believe that the remarks printed below do precisely that.—THE EDITOR.

IN ANSWER to your article on "Radio Power and Noise Level" in your September issue, which I have read with great interest," writes Professor Williams of Rensselaer Polytechnic Institute, "I must confess surprise at finding an article in your magazine written on such a high noise and such a low power level.

"As stated in your article, I do object to raising the power level of broadcasting stations for the same reason that I object to increasing the time assignments of existing broadcasting stations, and the addition of new broadcasting stations. All these changes increase the amount of interference experienced by radio listeners. It is strange, but true, that while the electric light and power companies, the telephone companies, the radio amateurs, and, in fact, all users of electrical energy who have been causing radio interference, have done everything within reason to eliminate interference, the broadcasters have done everything possible to increase interference. They act as if they want to make conditions so bad that the Government will have to step in with drastic governmental regulation. No doubt some of the more influential broadcasters might gain a material advantage through such a procedure, but the

great majority of broadcasters would find themselves in a position much worse than that which they previously enjoyed.

"In order to make my position on the question of power level perfectly clear to your readers, I will quote exactly what I said on this subject in my talk on interference at Hartford, Connecticut. 'The other limitation, which is the more important, that must be imposed upon radio broadcasting is that of intensity or power level. If we allow a large variation in power level, we make it extremely difficult to design and construct receiving equipment which can be operated by the average radio listener with equally good results over the whole intensity range. We in Troy have experienced more trouble from this source than from any other in the whole field of radio broadcasting. Radio listeners have constructed for themselves or bought so-called supersensitive sets with which they hope to hear the Pacific Coast and European stations; also the Troy and Schenectady stations. It has been our experience that it is impossible for the majority of these people to receive satisfactorily either the distant or the near-by stations. The near-by stations have an intensity which is too high to be received without distortion. The distant stations have a power level which is so low that they cannot be received in many locations without sufficient noise to make the reception unpleasant. You may think that this condition is the fault of the radio listener, and that he can be educated to use his set in such a way that these difficulties will be overcome. This is undoubtedly true in most instances regarding the reception from near-by stations, but it is not true regarding the distant stations. There is no place—at least I have been unable to find a place—where there is a zero noise level. The noise level does vary greatly at different locations, and a sensitive set which may function satisfactorily at one location will prove to be entirely unsatisfactory at another location. It is therefore evident, that at each location, there is a minimum signal strength which can be satisfactorily received on the most sensitive receiving set and if we attempt, at this location, to receive a program from a station which has a signal strength below this minimum, we receive so much noise along with the program that for all practical purposes the program is ruined. At first sight, it would appear that we could lower this minimum signal strength to any desired value by eliminating, in the territory considered, the various sources of noise. Theoretically this is possible, but practically and economically it is impossible. If the radio listeners require the Public Service Corporations operating in their territory to reduce the noise level produced by them, they would require these corporations to spend vast sums of money in changing equipment, improving insulation, etc. Eventually the public, which includes the broadcast listeners, would have to pay for these improvements. This would mean that the cost to the consumer of the services he receives from these corporations would increase proportionately. If the broadcast listeners carried their demand to the limit of no, or nearly no noise, it would mean that the public could not afford to pay for the service rendered by our public utilities, and the broadcast listeners would be, in fact, sacrificing the benefits they now receive from these corporations for the sake of improving and extending the range of their broadcast reception. As stated earlier in this talk, no one, when he realized what he was doing, would be willing to make this sacrifice. It is, therefore, necessary to establish a reasonable lower power level limit. Then if any particular broadcast listener wishes to construct or buy a sensitive receiver, which will receive programs below this power level, he should do it with the knowledge that, in general, he will not be able to use the extreme sensitivity of his set without experiencing disagreeable interference. If he is made to understand that what he is doing is, in every way, equivalent to placing a symphony orchestra in a boiler shop, very few will be foolish enough to do it, and our troubles from interference will be very materially reduced.

" 'With regard to the upper power limit, there is room for considerable difference of opinion. Our experience in Troy has convinced us that there is no necessity for these superpower broadcasting stations. When we know that a 500-watt station can be consistently heard throughout the cool weather all the way across this continent in one direction, and in Europe in the other direction, we can hardly be criticized for taking the stand that a power level of approximately this value is sufficiently high to meet the needs of the radio audience. When it is necessary to lift the power level all over the country, when something of national importance is being broadcast, it can be done very satisfactorily by linking by wires several broadcasting stations, chosen on account of their location.'

"Comparing the above with your remarks in the September RADIO BROADCAST, it is evident that we are in substantial agreement with regard to the necessity for a low power level limit. If this level is established sufficiently high so that 'static' interference is not disagreeable, we can unquestionably keep man-made interference at the same level as 'static' interference, and thus also avoid this form of interference.

SUPER-POWER VERSUS SUPER-BROADCASTING

"WITH reference to the upper power level, we agree that this should be maintained as high as practicable, and differ only in our methods of obtaining this high power level over large areas. Your method is to use a super-power broadcasting station; my method is to use a super-broadcasting system, by which I mean, as stated above, several broadcasting stations of approximately 500 watts connected by wires. With your system you would have an excessively high power level in the neighborhood of your super-power station, and this power level would fall off rapidly with distance from your station. With my method you would not have an excessively power level at any point, and you would have a more uniform power level over the

area to be covered by the program. By my method an average power level could be maintained at a higher value than by the one you suggest.

"You use the electrification of our railways as an illustration of the centralization of power production, which you think should be followed in the case of radio broadcasting. Do you propose a super-generating station at the central points of our transcontinental railway systems to feed energy over the entire line? Do you not know that it is the intention of those who are considering the electrification of our railway systems to take the power required from our super-power systems? And what is a superpower or giant power system in the minds of those who are forming them? It isn't a super-power plant, but a relatively large number of generating stations connected by transmission lines. In such a system, the electrical energy consumed in a given locality is, under ordinary operating conditions, produced at the power plants originally designed and constructed for supplying the energy to that part of the system serving the given locality. This system is interconnected by transmission lines with its neighboring systems so that, when necessary, there can be an interchange of energy between the distributing systems by means of the connecting transmission lines. The general opinion of power engineers on this subject is stated, as follows, on page 438 of the July 1925, *National Electric Light Association Bulletin*:

During the past decade, the rapid growth of the industry has required the greatest amount of attention to a development which was marked at every step by notable increases in size and capacity of the individual components of our physical plants. In studying the trend of growth for the future, it is quite likely that the necessity for a continuing increase in capacity of equipment will be far less than we have been forced to meet during the past decade. Further increases will be largely determined by the economics of the situation, and while estimates of future growth indicate that the total energy demand will treble during the next ten years, there is little likelihood that unit capacities of equipment for generation and distribution will increase in anywhere near the same ratio.

I have been intimately associated with the electric light and power industry for the past twenty years, and am not aware of any tendency in the direction of super-power plants, but am entirely in sympathy with the trend toward the consolidation of transmission systems, and the ultimate establishment of the so-called super-power systems.

LINKING A DEVELOPMENT IN THE POWER AND COMMUNICATION FIELDS

"IN THE communication field we have a similar development. The local telephone exchange gives the community which it serves local telephone service. The American Telephone and Telegraph Company, with its long distance lines interconnects these local telephone exchanges into a super-telephone system, which gives national telephone service. The writer has studied the development of the telephone industry in this country for the past fifteen years and is unaware of any tendency toward the development of a super-telephone office, but is aware of the fact that the interconnection of these offices by telephone transmission lines has produced the super-telephone system.

"In your article you endeavor to show by computation, the advantages of a 50 kw. broadcasting station from the point of view of economy. Let us carry your argument a little further, and see what conclusions we arrive at. On Page 117 of the November, 1922, *Bell System Technical Journal* we find the following:

Economy of transmission requires the handling of messages at as low an energy level as possible and, as the author points out, wire transmission satisfies this requirement much better than radio. Referring to the transcontinental line with radio extensions, which was used recently to talk from Catalina Island in the Pacific Ocean to a ship in the Atlantic Ocean, it is stated that, had all of the necessary energy been introduced at one end of the circuit, there being no intermediate amplification, the total power required would have been 1.8×10^{29} kilowatts, an amount unavailable in the world. In the actual system, distributing the amplification along the transmission line, the power required sums up to something less than 1 kilowatt.

This statement needs no amplification by me. I have used it for the reason that the data have been taken from an actual transmission problem and is, therefore, not academic. If your readers will write down 18 with twenty-eight zeros after it before they come to the decimal point, they will have some idea of what will be required in the way of a super-power station if you wish all the amplification to be transferred from the receiving set to the transmitting set, which is the development suggested in your article.

"The super-broadcasting system, suggested in my article, operates on exactly the same principle as that used on this transcontinental line. It would be operated between perfectly definite power level limits and for the same reason that the transcontinental telephone line is operated between perfectly definite power level limits. In telephone transmission, the power level must be maintained above the noise level so that the noise does not interfere with articulation. The upper power level is maintained as low as practicable so as to reduce the interference between the various telephone circuits. The electric light and power engineers in this country are very anxious to have the communication systems increase their power level, as it would reduce very materially the interference produced by the light and power systems in the communication systems. The telephone engineers object to raising their upper power level because they know, from experience, that increasing this upper power level increases the interference from one telephone circuit into another. Increasing the upper power level for broadcasting by the use of super-power stations produces practically the same

kind of interference between stations in the receiving sets, and when broadcasters have had a little more experience they will be no more anxious to increase their upper power levels than are the telephone engineers.

LOCAL BROADCASTERS AS OPPOSED TO "SUPER" ONES

"CONTRARY to the statements made in your article, if we wish to take advantage of the past experience of power and telephone engineers and develop broadcasting along similar lines, we must have local broadcasting stations for local service, which may be interconnected, thus forming super-broadcasting systems when we wish important programs to cover large areas efficiently, economically and with minimum interference.

"We are at a loss to understand why your magazine has completely reversed its opinion with reference to 500-watt stations. Two years ago this winter you asked WHAZ to coöperate with you in your transatlantic tests. At that time we were using a little less than 500 watts in our antenna and yet, according to your own report, we made a very creditable showing in spite of the fact that a larger powered station operating on the same wavelength, occupied approximately one half of our broadcasting period, leaving approximately only eight minutes for the broadcast listeners on the other side of the Atlantic to tune-in station WHAZ. These and other long distance listeners were not, as you say, 'batted in the ear by crashes of static, violet ray machines, electric bells, door-openers, and other miscellaneous natural and artificial noise makers.' If you will procure and read a copy of the National Electric Light Association's serial report of the inductive coördination committee, technical national section, *Radio Interference* published July, 1925, you will find that arrangements have been completed for making the noises you refer to part of radio's ancient history. Why resurrect this corpse and use it for an argument in favor of super-power stations?

WHY WHAZ ISN'T HEARD OFTENER

"THE real reason why fewer long distance listeners are unable to pick out 'the mystic letters WHAZ' is because they are "batted in the ear' by their so-called local superpower and the squealing produced by the heterodyning of carrier waves from too many stations broadcasting simultaneously.

"You say that 'a large station costs a pile of money and all that one gets from the disbursement, besides the ability to address the populace, is the privilege of spending a lot more cash to keep the thing going.' This statement would lead one to believe that the scramble one witnesses at a radio conference for more time, more stations, and more power is due to the anxiety of the broadcasters to spend their money for nothing. This is absolutely false. The reason why our present broadcasters are asking for more time and more power, and new broadcasters wish to enter the field, is because they know 'it pays to advertise.' What sense is there in telling the public that radio broadcasting stations are philanthropic organizations, when anyone who has sense enough to read knows it isn't so? Can any one imagine the stockholders of a radio manufacturing concern voting large sums of money to be spent for entertaining the public without any money return to the corporation? The groaning broadcasters referred to in your article are as hard to find as the missing link which would have been of so much value recently at Dayton, Tennessee.

"You say that 'among all the sounds heard in broadcasting studios, the jingling of the cash register is the least frequent.' Do you not know that no one expects to find cash registers in the advertising department of any business, and that they are found in the sales department? Any one who has purchased radio apparatus has heard the cash register jingle more than once. The stores that operate broadcasting stations have their cash registers behind the counter or in the cashier's cage. The hotels that operate broadcasting stations have their cash registers in the cashier's cage, etc. If the cash register manufacturers are losing business through broadcasting, the writer doesn't know it.

"In your enthusiasm for those who have money to spend on super-power stations you say 'If Mr. Williams wants to reduce station interference, he should advocate a reduction in the number of poor transmitters by enforcing decent standards of service, instead of opposing the sound engineering adjustments of organizations with the resources and determination to maintain the progress of the art. And, if he will ponder a little on the difference between the 'I-think-I-heard-your-station-last-night' range, and the effective service range of a station, he will perhaps reconsider an argument which is reminiscent of the early days of automobiling, when it was decreed that a flagman had to walk ahead of each automobile to prevent it from scaring horses.' Let us look into this matter and see if it is as foolish as it sounds. Bringing the idea of your flagman up to date, are you not aware of the fact that the 1925 flagman is represented by our various State Motor Vehicle laws, with the required personnel for enforcement? And why is the 1925 model flagman necessary? It is because automobilists, with resources in the form of automobiles and determination in the form of a well filled gas tank, have attempted to use our public highways without due appreciation of the rights of others to use these same highways unmolested. Are you asking me to advocate the construction and operation of super-power stations by those organizations which have the necessary financial resources and influence, to mislead them into believing that they may ride rough-shod through our ether highways, without any regard for the rights of those localities that wish to operate lower powered broadcasting stations, and use the same ether highways unmolested? We agree that there are too many 500-watt stations operated simultaneously at the present time. We also know that conditions will be worse than they are now, if all these stations

increase their power. This is why I refuse to advocate the use of super-power. I know that each section of these United States has as much right to the use of the ether as any other section, and I do not believe the American people will ever stand for a monopoly in broadcasting, either by one section of the country or by one corporation.

LIMITATION OF POWER NECESSARY

"SINCE each section of the country has an equal right with every other section to broadcast, we must expect to have a relatively large number of broadcasting stations, and the only possible way of operating them simultaneously, without annoying interference, is to limit their power. The separate stations can then operate independently for local service and can be linked together by land wires for national service. If this method were followed, there would be less necessity for a flagman of the ether and I am of the opinion that the fewer laws required to regulate broadasting the better for everyone. This is a question, however, which must be eventually settled by the radio audience, so let us see who they are.

"In your article you ask 'What is the radio audience and what are its demands?' You indicate your answer as follows: 'We shall be surprised, indeed, if the members of this WHAZ audience do not send us loads of poisoned cigars, live tarantulas, and infernal machines.' We will have to part company with you on this subject also, as we have found the radio audience intellectually on a par with the broadcasters and we are very grateful to them for the manner in which they have shown us their appreciation of our endeavors in the broadcasting field. They believe in free broadcasting as thoroughly as they believe in free speech. They have indicated in the past that they can recognize a monopoly in the forming and that they have no intention of standing for a radio monopoly. We believe that the radio audience are intelligent and that if they decide to have a radio broadcasting station of any size in a certain locality and are told that the cost will be prohibitive, they have back-bone enough to start an investigation to determine why powerful radio broadcasting equipment is so expensive, and determination enough to carry the investigation through to a conclusion, and thus put the skids under that argument.

RADIO AT WHAZ

NOW I wish to say a few words regarding the broadcasting activities of this Institution. The Rensselaer Polytechnic Institute has had broadcasting equipment since the winter of 1909-10. It was procured at that time because we believed it had a great future, although it was known then by the unpretentious name of a wireless telephone. We believe that, in the future, innumerable practical applications will be found for high frequency electrical energy and for that reason we are, at this time, designing and constructing an addition to our radio laboratory, which will give us approximately 3000 square feet of additional floor space. Educational institutions are not made of money but some of them have an uncanny way of looking into the future. This Institution intends to use this additional laboratory space for laying the foundation for our part in this future development. As soon as we find it necessary for our purpose to have a 5 kw. or a 50 kw. transmitter, we will have it. You may rest assured on that point. We have been drawn into this broadcasting controversy because we had the audacity to use our laboratory equipment for part of one evening each week for broadcasting. Practical engineers, to say nothing of academic ones, never start anything they can't finish, so you are quite likely to find this station interested in this controversy until a solution is found which meets the needs of the American public.

Sizzi wouldn't have those moons

"In closing, I wish to restate what everyone knows, who has anything to think with and uses that God-given power:

(1) The American people are worthy of, and will have, the best local, national and international broadcasting, and they will have this service with a minimum amount of interference.

(2) In order to reduce interference, upper and lower broadcasting power levels must be established.

(3) There are too many Class B Stations operating simultaneously, and to allow these stations still further to increase their power can only result in making conditions worse.

(4) The most economical, efficient and satisfactory system will limit the power used by stations for local broadcasting, and will unite these local stations into a super-broadcasting system for national service.

(5) There can be no private broadcasting monopoly, either by a section of this country or by a corporation.

(6) It pays to advertise—broadcasting at present is advertising, therefore, broadcasting pays.

(7) The radio public pays for broadcasting and what they pay for they will control."

Mr. Dreher's Reply

ALONG in the very early part of the seventeenth century, Galileo, having devised a sufficiently effective telescope, was able to view the four moons of Jupiter. When he announced his discovery, all the Aristotelian astronomers of the day, who had their jobs and were satisfied with the heavens as they knew them, rose in horror. One Sizzi, a learned star-gazer of Florence, declared that as there were only seven apertures in the head: two eyes, two ears, two nostrils, and one mouth; and as there were only seven metals (he was sure of that), and seven days in the week, so there could be only seven planets. Being persuaded that the four satellites were actually visible in the telescope, the scholarly Sizzi shifted his position a trifle. He now argued that as the circumjovian planets were invisible to the naked eye, they could exercise no influence on human beings, they were useless; finally, therefore, they did not exist. In short, Sizzi just wouldn't have those moons, and that was all there was to it.

With apologies, I must confess that Professor W. J. Williams' remarks regarding my article on "Radio Power and Noise Level" in the September RADIO BROADCAST affect me much like the arguments of the staunch conservative Sizzi in his day. It is true that I have not invented a telescope, nor made any celestial discoveries. With touching modesty, I confess that I see no resemblance between Galileo and myself, but I do feel that a comparison between Professor Sizzi and Professor Williams is not too far fetched. As Sizzi clung desperately to the mystic number *seven*, so Mr. Williams will never abandon *five hundred*. Five hundred watts, that's the power for a good honest broadcasting station! It was good enough in 1922, and why shouldn't it serve now? *In youth it sheltered me, and I'll protect it now!* as we used to declaim in the high school elocution classes. As for any higher power, Professor Williams simply won't see it.

At no point in his argument is Professor Williams courageous enough to discuss, simply and without obfuscations my contention that the addition of a stage or two of audio amplification to the listener's signal, *without a proportionate rise in the noise level*, would improve broadcasting as a public service, stabilize the industry, free it to a great extent from seasonal variations, and benefit everyone concerned except, perhaps, the owners of a few antiquated and unprogressive broadcasting stations. Instead, he begins with a restatement of his dicta on noise level. He has apparently never heard of an effective volume control on a receiving set, for he repeats his entirely erroneous notion that it is not feasible to design receiving equipment capable of distortionless reception from powerful near-by stations as well as distance work. Such a sensitivity control costs about twenty cents, and there are almost as many ways of doing the thing. His attitude toward radio noise is apparently quite fatalistic, as in his Hartford address, where he declared that the radio art, being in its infancy, must be expected to be noisy! This is like saying that there is no reason why men should wear belts or suspenders, for they can hold up their trousers with their hands. He compares distance reception to placing a symphony orchestra in a boiler shop, and says that it is a very foolish thing to do. There we agree. But it is not half so foolish as continuing to suffer noisy reception when one can overcome these disturbances. I do not understand Mr. Williams's supine and complacent attitude with regard to this problem. An engineer is not expected to turn his back on difficulties; he is supposed to be trained to overcome them. By increasing transmitter power, we can proportionately reduce amplification at the receiver, thereby riding over disturbances without any increase in station interference whatsoever. Professor Williams, who is not a radio engineer, and whose talk, to which I took exception, was not delivered before an audience of radio engineers, persists in dragging all sorts of bogeys into the field which it has pleased him to invade at this late date. Finally, when he does come down to figures, he quotes the computations of a telephone engineer, which I used myself in an article for *Radio* two years ago, to the effect that, if one tried to get as much voice power at the receiving end of a line, without repeaters, as one can get with them, the required input to the line would be 1.8×10^{29} kilowatts. This is glorious, but what is its relevancy? This is what Professor Williams calls carrying my argument for a 50 kw. station "a little further." By what right? I gave my figure, and I knew what I wanted to say. If I want to ride from Boston to Providence, must I go on to Washington, because the conductor of the train goes that far?

why wear belts or suspenders?

Apparently Mr. Williams sees some antithesis between wire line transfer of programs and superpower. He devotes several hundred words to arguments in favor of linking up stations by wire lines. Every radio engineer will agree with him heartily. We know the advantages and disadvantages of wire lines, and use them whenever it is expedient and we have the money to pay for the lease. But if all the 500-watt stations in the country—to name the power which has become Professor Williams's fetish—were to be linked up by wire lines, there would still

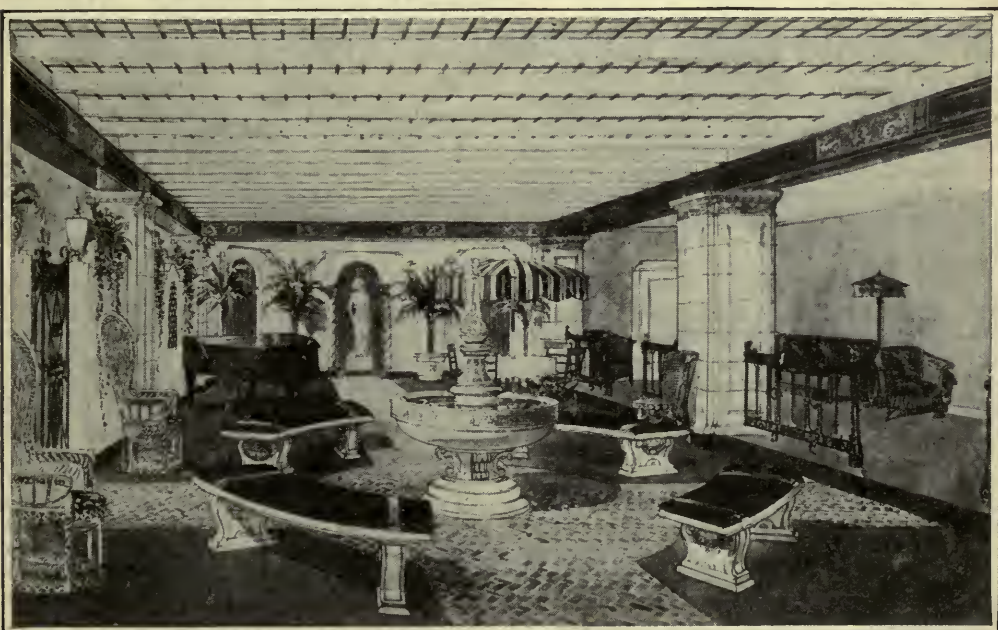
be vast areas unprovided with program service, and every time a lightning storm came up (static has remarkably little respect for 500 watts in the antenna) all the listeners who lived more than a mile from one of those stations would encounter a certain amount of unnecessary interference. By all means, when we have stations of adequate power, let them get their modulation as best they can—by bringing their artists to the studio in airplanes, or by the use of wire lines umpty thousand miles long, or in any other way that works.

CONTINUOUS PROGRESS IS NEEDED IN RADIO

PROFESSOR WILLIAMS' complete insensibility to the need for continuous progress in a field like radio broadcasting amazes me. I should like to know, for example, what he would do about transoceanic or international broadcasting. Would he permit the erection of a super-power station or two for that purpose, or would he forbid that also, on the ground that it might interfere with reception in the rural location in which it would naturally be placed, or that it might encourage the growth of, the nefarious monopoly which agitates Professor Williams's imagination so violently? Would he try to send a program over to France for re-broadcasting there, or get one from England, with his all-encompassing $\frac{1}{2}$ kw.? His predilection for that power reminds me of nothing so much as the sacred decretals of the pious Bishop Homenas in Rabelais, with which he hoped to redeem mankind, and to accomplish all things good. It is not at all certain that the Professor would not attempt this, for he says flatly, in his reply to my article, that the European listeners to WHAZ in the transatlantics two years ago "were not, as you say, 'batted in the ear by crashes of static, violet ray machines, electric bells, door-openers, and other miscellaneous natural and artificial noise makers.'" Heaven, then, intervened with a miracle, and the European listeners heard WHAZ against a quiet background. Has the man ever listened to DX at all, or is he only writing about it? Luckily for the radio business, a lot of radio listeners are situated so close to broadcasting stations that they are able to get quiet reception, by virtue of the powerful fields that Professor Williams can't abide, even in prospect; but before we get through there is no reason why everyone who wants to buy a radio set, should not be able to enjoy freedom from disturbances practically all of the time.

Professor Williams is an optimist. He says artificial inductive noises have been eliminated. He quotes a report. Well, then it must be so. Only, someone should inform the noises that they have been eliminated. With all due credit and encouragement to the men working on this problem, I am bound to say that considerable noise is still getting by them. Besides, Professor Williams himself points out that there is a limit below which it is not practicable to go in electrical noise suppression. The remedy lies only partly in attacking artificial noise at the source; the signals of broadcasting stations should be brought up to a level where every cat rubbing his back against a fence will not interfere with reception.

In the matter of the electrification of railroads, and giant power, I will yield the field to my opponent. There I freely acknowledge that he knows more than I do, and it is therefore proper that



ARCHITECT'S DRAWING OF THE NEW WJAZ STUDIO AT CHICAGO

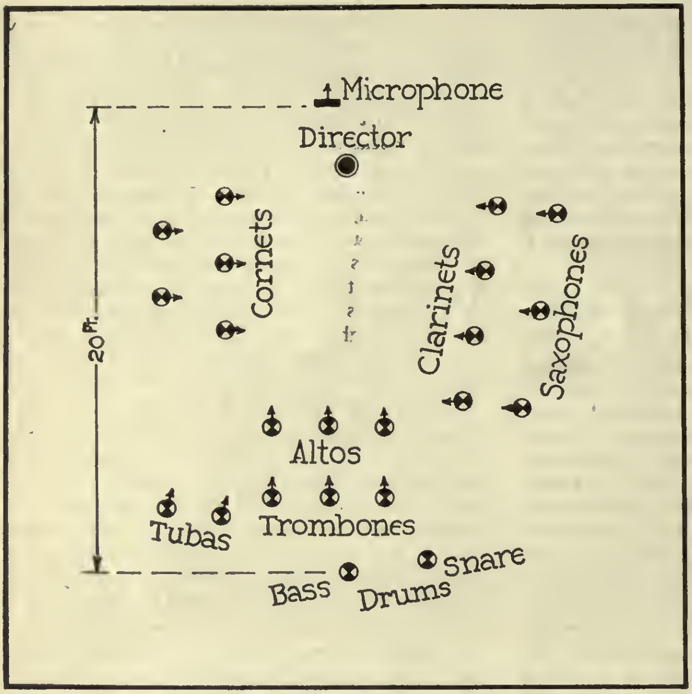


FIG. 1

An effective studio set-up for a brass band in a small broadcasting studio, twenty-five by nineteen feet. In this particular case, a typewriter cover was placed over the microphone to lessen volume

and I know they do not possess. This sort of playing to the galleries is deplorable in a teacher of science and technology. We want engineering data, not rhetoric. We can get the latter on any street corner around election time.

Professor Williams seems to think it necessary to defend WHAZ. I have no doubt that WHAZ is a good station. I wish I could hear it on those Monday evenings when I am told it is on the air. I can't, with any degree of pleasure, although I'm not 150 miles away. If R. P. I. intends to get the 5 kw. or 50 kw. station that the Professor hints at, all I have to say is: "Congratulations! Welcome to our city! But in the meantime, gentlemen, don't obstruct traffic. You may join the parade when you are ready."

By the time this gets into print, genuine super-power stations will, I hope, be audible on the air. I believe it will not take many months of use of these transmitters to convince Mr. Williams that he was wrong in his views, honestly mistaken, no doubt, but mistaken. After all, he and I can talk ourselves dry and in the end the issue will be decided by performance. So I am content to leave the ultimate decision to the future.

I should defer to him. I used this process as an illustration. If it was not an apt illustration, I am glad to be corrected.

Professor Williams' treatise on the location of cash registers is really too absurd. All I have to say is that the editors and readers of this magazine do not encourage dull writing in their contributors. They understand a bit of sarcasm and do not write a homily about it. Of course the broadcasters are not altruists. They are working for the same two ends that Professor Williams strives to attain: to earn a living, or better; and to be useful in the world, if possible.

THERE IS NO MONOPOLY IN BROADCASTING

MONOPOLY! Already about twenty stations in this country are going up in leaps and bounds to the 5 kw. level, including department stores; electrical, radio, and phonograph manufacturers, schools of chiropractic, newspapers, churches, and communication companies. Where is the monopoly? And the 50 kw. and 100 kw. broadcasting stations built or building in England and Germany, are they a part of the world-girdling octopus? Stuff and nonsense! Everybody is increasing power who has the money, because it is the next sound technical step. Professor Williams tries to put me in the position of traducing the radio audience. Why should I? I earn my living through it. I refuse, however, to flatter the listeners by attributing to them technical knowledge which both they

WJAZ's New Studio

THE photograph on page 767 shows one view of the new Zenith broadcasting studio located on the twenty-third floor of the Straus Building in Chicago. The call letters of the transmitter are WJAZ, the same that were used by the earlier station of the same company at the Edgewater Beach Hotel.

The new broadcasting parlor does away with drapes and Monk's Cloth for purposes of keeping down reverberation, but accomplishes the same object by suitable acoustic treatment of the walls and ceiling, an expedient which is not novel in this field, but seldom employed because of the increased expense. However, it looks much better and is worth the expenditure.

There is a large reception room with tapestry and rugs and period furniture, and from this an artistic archway leads one into the studio, laid out to suggest a garden, with stone seats, statues, and a real fountain in which Japanese goldfish are permitted to listen to the broadcasting. The floors are tiled; potted plants and an awning may also be seen. The only way you can tell that it's a studio is by the piano.

According to reports, lighting effects are to be introduced for the inspiration of the artists. Some of the dear things need inspiration, heaven knows. For instance, let one of them sing of love, and the garden will be bathed in moonlight, etc. Quite an idea. We have been advocating the use of symbolic microphone stands ourselves, be it remembered. But what will happen to the operator of the lights at WJAZ when he gives some nervous soprano a spot which doesn't suit her complexion!

More About How to Place the Microphone

CONTINUING with our technical series for broadcasters, we show in Fig. 1 a very successful studio set-up for brass band, due to Mr. F. D. Leslie. This was a Naval band playing with great energy to a carbon microphone in a 25 by 19 studio, so that it had a decided tendency to blast. The microphone was turned back to the orchestra, with its sensitive side toward a fairly dead surface, and a typewriter cover was slung over it. The typewriter cover was a rather barbarous expedient, but if it took out the higher frequencies, as theoretically it might be expected to do, the difference was not noticeable on the air, and there was certainly no blasting. This set-up should be compared with the arrangement for brass band shown in Fig. 3-B last month. The principal difference, aside from the reversing of the microphone, is in the position of the cornets, which in the present case are ranged on one side of the room on a line perpendicular to the plane of the microphone.

Fig. 2 illustrates the outdoor pick-up of the New York Philharmonic Orchestra of 110 men, conducted by Willem van Hoogstraten, at the Lewisohn Stadium in New York City. This is full stature symphonic material, all the Brahms symphonies being played during the season of about two months, most of the Tchaikowskys and Beethovens, and others by Schubert, Mozart, Schumann, Dvorak, Rachmaninoff, Respighi, and Rimski-Korsakoff. The popular overtures and light classics find no place. The management is rather proud of the fact that in the last few years the programs have been built "without concessions." Nevertheless, audiences as high as 11,000 a night attend these open-air concerts.

The orchestra plays on a stand surmounted by a huge reflector, and flanked by sounding boards. The spread of the orchestra over a front of about sixty feet makes the pick-up somewhat complicated. Using carbon microphones, a combination of close and overhead pick-up is found suitable. It is clear from Fig. 2 that the two overhead microphones, receiving sound directly from the orchestra as well as from the reflector, may be made to do the bulk of the work. They are far enough away to obviate blasting, and near enough to handle loud and medium passages. At a pinch they will also do for pianissimo portions, single instruments, etc., but the gain must be brought up to a point where the hiss is objectionable and such disturbances as automobile horns on nearby streets come in faintly. For first-class pick-up, therefore, a third microphone is placed on a stand two or three feet from the conductor and concert master. This microphone has its individual gain control and it is kept throttled

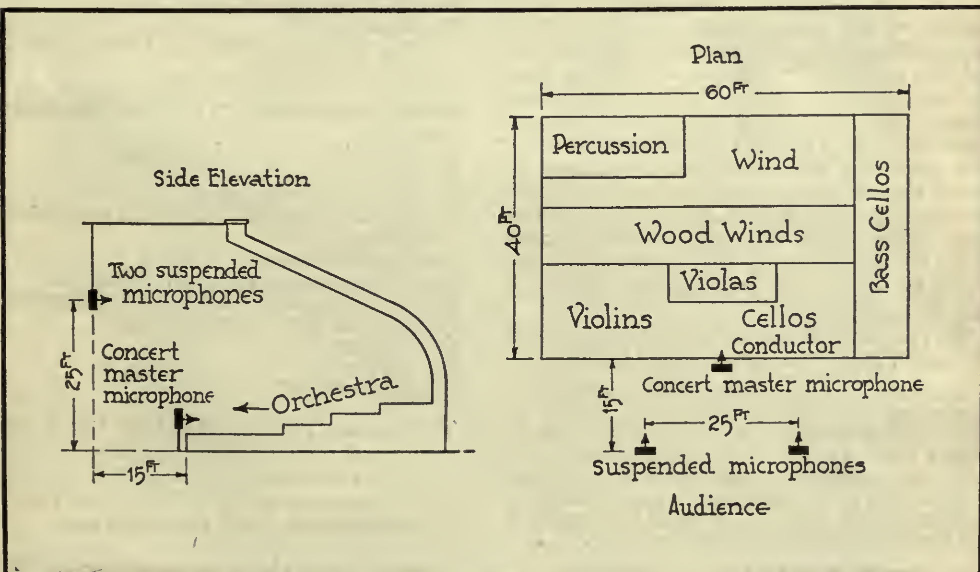


FIG. 2

The Lewisohn Stadium at New York, where the New York Philharmonic Orchestra presents its famous Stadium Concerts. This concert, in common with many others of its type, presents some genuine problems. Mr. Dreher discusses in the accompanying article the way in which they are solved

down much of the time, for it is so close to the players that full orchestra will cause it to blast. During low passages, however, it is swung in noiselessly and it will pick up single instruments with great detail and no hiss to speak of. This requires some finesse, of course, on the part of the man operating the amplifier.

The job might be done with only a single microphone suspended about fifteen feet in front of the orchestra stand and twenty-five feet high, together with the concert master's microphone for the low portions, but two suspended transmitters give somewhat better reproduction over the wide front of the orchestra seating. As Philharmonic audiences are perfectly quiet during the performance, there is no need to watch out for crowd noise, and the fact that part of the audience sits under the suspended microphones is of no consequence, except that the suspension must be made as safe as possible. The cables are good for 800 pounds ($\frac{5}{16}$-inch galvanized steel rope); and as two carbon microphones weigh five pounds, it is unlikely that accidents will occur. This is a rather important factor in field broadcasting; one must look out for the artistic features, of course, but care should be taken not to jeopardize the audience. A two-and-a-half-pound lump of steel does not have to fall very far to crack a man's skull.

Fig. 3 is a photograph of the general lay-out at the Lewisohn Stadium, showing the microphone suspension and the orchestra stand. The broadcasting of the Philharmonic Concerts is by WJZ, WGY, and WRC being connected to it by land lines.

A very similar job, technically, is the transmission of the Goldman Band, which plays on the campus of New York University. Fig. 4 shows the disposition of the microphones. This orchestra is strong in brass, with the addition of a string section, and the number of players is considerably less. The selections are largely marches and popular classics. The broadcasting company in this case erected a frame of two-inch iron pipe for the overhead suspension, and did not find it necessary to spread the two microphones; they are angled off somewhat, however, to face the two halves of the band. There is also a microphone near the conductor for the close work. The pick-up in this case is done by WEAF and the modulation is sent on to a long chain of stations.

The radio critic of the New York *Herald-Tribune*, "Pioneer", says of these two summer features:

> There are two downright perfect examples of microphone placement and balanced pick-up of large orchestras which this summer has produced. WEAF's pick-up of the Goldman Band and WJZ's ditto of the Philharmonic Orchestra, achieve effective reproductions of the entire orchestras, which have never before (to our ears, at least) been equalled and between which there is little to choose.

Well, *perfect* is an elastic word, and what is perfect this year will be in the garbage can next summer, for electrical reproduction of music has this characteristic—anything at all good sounds fine . . . until you have something better to compare it with. Only then do its faults stand out. However, on a good flat receiving set and loud speaker, these two jobs really appear to get quite close to the actual performance of their respective orchestras. The details of the simple pick-up used may be of interest to other broadcasters at this time.

The Memoirs of a Radio Engineer. V

I RELATED, in the preceding issue, the melancholy story of how wireless urchins were persecuted in 1909, resulting, in our case, in the loss of our four-wire flat top antenna. We continued our experiments without an antenna. By some means we secured a small induction coil of the type used for home "medical" treatment of rheumátism, a "shocking coil" with electrodes gripped in the hands which would impart quite a "wallop" when the apparatus was adjusted to give maximum voltage. By using excessive primary voltage on this coil we were able, at times, to draw a $\frac{1}{32}$-inch spark between needle points across the secondary. We made a spark gap out of tin cracker cans, the electrodes being cut to very sharp points. This was a sort of radio transmitter, capable of producing a buzzing sound in the telephone of the steel-carbon detector, at distances of six or eight feet, when the vibrator was not sticking, and the spark gap not in excess of the $\frac{1}{32}$ inch which was its absolute limit.

Near the end of 1909 I made an inventory of our possessions in a small memorandum book, which I still possess. Some of the items are as follows:

> Alarm, burglar, made home, good.
> Battery, about run out.
> Buzzer, made home.
> Bottles, numerous.
> Catalogues, useful.
> Carbon, powdered, from dry battery, also in chunks.
> Foil, tin.
> Galvanoscope, small, very sensitive to week currents.
> Junk, of every kind and description.
> Jar, Leyden, unbreakable.
> Magneto, Etheric Co., good.
> Magnet, large, powerful. Increased power of the magneto.
> Mercury, very little.
> Motor, Gem, power and speed. Runs fine.
> Press, printing, for printing laboratory literature.
> Resonator for the telegraph, small.
> Saw mill, toy.
> Shaft, counter.
> Wood, under closet.

The printing press, it should be stated, was merely one of those small wooden forms in which rubber type could be inserted to print more or less legible sentences in red ink. With it we printed the following report, dated December, 1909.

> Red Seal batteries have been pronownced run out and have had binding posts removed. The ever readys are of no more use. Have bought an X ray, very good. Motor and Mesco Engine run fine. Have built during the past month a winding gear for the motor, and a key for the telegraph, also

FIG. 3

The complete arrangements for broadcasting the New York Philharmonic Orchestra from the Lewisohn Stadium, New York. Note the placing of the various players. Three microphones, well placed and controlled, are sufficient for the pick-up, which has been rated as one of the best bits of broadcasting ever done. WJZ, WGY, and WRC do the broadcasting

a buzzer. Good quantity of wood in stock. Have made this new index book. Now for 1910.

The X Ray, bought after the batteries had been *pronownced* run out and subjected to removal of binding posts and no doubt evisceration for the salvaging of the powdered carbon, was also a dry cell, not, as the report might be taken to mean, a Roëntgen outfit or anything else so elaborate. It will be noted, also, that I had not reached the stage of quantitative exactness. There was the galvanoscope, "very sensitive to week currents," —but no one knew just how "week" those currents were, and the magnet, "large, powerful," which increased the power of the "good" magneto. A similar uncertainty manifests itself in the spelling. In fact, the book exhibits two individualistic spellings of "catalogue,"—"catalouge" and "catalougle"; and I was in some uncertainty as to whether an engine ran "fine" or "finely." But these were small matters. In the words of a popular play, we knew what we wanted.

What was the status of commercial radio in 1909, is a question that may occur to some readers while I devote so much space to the infantile flounderings of our group of boy radio wonders. As I have stated previously in these articles, there were many amateurs ahead of us, and the commercial interests were leading the amateurs by a very comfortable margin, such investigators as Stone, Fessenden, De Forest, Massie, Pickard, Shoemaker, and numerous others having been at work in this country for some time. In 1901, Marconi had succeeded in transmitting the letter "S" across the Atlantic from Poldhu, Cornwall, to St. John's, Newfoundland, a distance of 1,800 miles, and in 1909 the Glace Bay-Clifden circuit had already been in commercial operation for two years. In England the year 1902 saw the invention of the Fleming valve, to which the grid electrode was added in 1906 by De Forest in the United States. In the same year Professor R. A. Fessenden was working at Brant Rock, Massachusetts, on his high-frequency alternator and numerous other inventions. Even radio telephony, or aërophony, as it was frequently called at the time, had made appreciable progress, although the quality of transmission had not yet attained any celestial heights. In 1907 De Forest made experiments in wireless telephony on various naval vessels and succeeded in transmitting, on occasion, over distances up to sixty miles, using arc sets. The Poulsen arc was fairly well developed by 1908; and Marjorana telephoned with an arc modulated by a water microphone from Rome to Sicily, a distance of 300 miles.

In 1909, the great Nauen station was already in operation in Germany, and preparing for communication with the United States. It had a 330-foot tower, an umbrella antenna, and a 25 kw. alternator. Messrs. Slaby and Arco, the chief engineers of the Telefunken Company, working on the inventions of Wien and others, had produced a complete and efficient quenched spark transmitter, which was as far ahead of the straight gap sets of the day as the modern tube transmitters are ahead of it now. In the neighborhood of New York things were lively enough. The 42 Broadway station of the United Wireless Company, call letters NY, erected in 1904, was in full operation, and many operators still remember its snappy 250 cycles calling AX (Atlantic City) in American Morse, under the capable fist of Mr. J. B. Duffy. The Waldorf Astoria roof bore two towers, and Mr. Pickerill presided over the station, which had the call letters WA. There was also a 2 KW. transmitter on the Hotel Plaza, with the spark gap placed in a wooden "safe" to prevent it from disturbing the slumbers of the guests. Its call letter was "P" and that was all it needed; the day of four-letter calls was still far in the future. Whether "DF," the Manhattan Beach station, was still in operation, I do not recollect at this instant, but De Forest had been making experiments on the incompleted Metropolitan Tower, and in 1909 he declared, "I feel certain that within a short time we will be able to be in wireless communication with the Eiffel Tower in Paris," a prophecy which was not fulfilled until 1915, and then by the American Telephone and Telegraph Company. There was also a fine antenna on the 71st Regiment Armory in New York. I recollect seeing it, but the call letters escape me. Nor were other sections of the country much behind. On the Great Lakes, there were stations at Port Huron, Detroit, Toledo, Cleveland, and Buffalo. In California there were stations at San Francisco, Mare Island, Sacramento, and Santa Barbara. On Cape Cod, MCC, operated by the Marconi Wireless Telegraph Company, was in operation not much later, and the Navy had a station at Key West. These are only a few among many deserving mention, and no doubt many of the old operators will feel aggrieved and write me, "What about Cape Race, and this, that, and the other station?" Radio was still in its days of struggle, and there was little money, and a vast amount of ignorance, but it was moving, here was no doubt of that.

Microphone Miscellany

A Free Bath. Advertisement of a manufacturer of condensers: "By-Pass Condensers do a double job. They filter the fluctuating B battery current. They provide a free *bath* for the radio frequency currents. . . ." Yes; it was printed that way in at least two magazines.

Imagination Is a Great Thing. Ingenious blurb issued by the press agent of a chain of stations:

Those who are not fortunate enough to be able to spend their summers by the sea at least can have some compensation Sunday nights during July and August when programs are broadcast direct from the Steel Pier at Atlantic City.

The refreshing sounds of the surf beating on the shore will be relayed from the famous resort and sent out to keep the radio fan cool in sultry weather, a specially constructed microphone being housed under the furthermost point of the Steel Pier, directly over the surf, for that purpose.

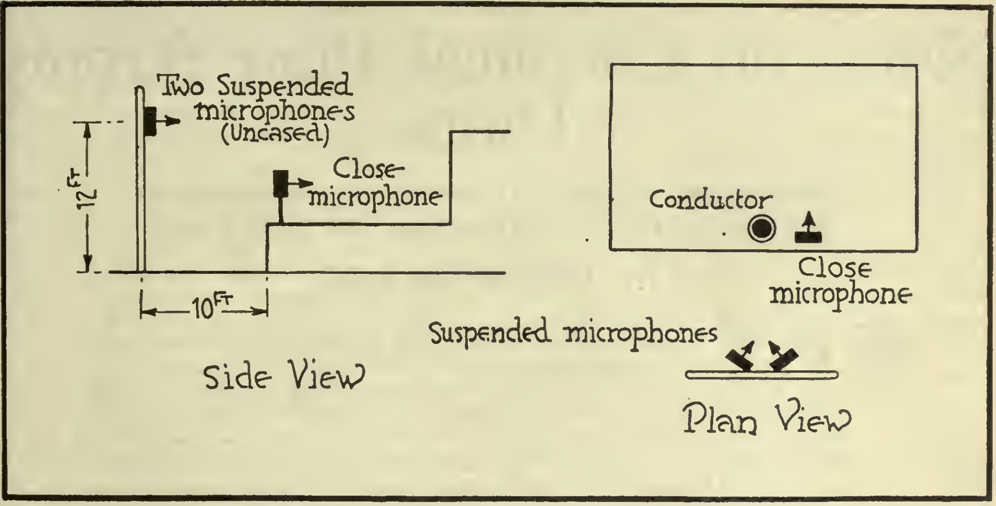


FIG. 4
The microphone set-up used by the American Telephone and Telegraph Company in picking up the Goldman Band, playing at the stadium on the campus of New York University. The WEAF engineers have done the work of installation and the programs are broadcast through a chain of stations

Thus refrigeration by radio has become a reality. Can one take one's baths that way also? Will not a microphone suspended in some lobster palace, carrying the sounds of mastication and imbibition to the radio audience, satisfy the hunger of the listeners and save heads of families several kopeks a day? Must we breathe, when an air-compressor can be set up to make respiratory sounds for everybody with a radio set? Go to it, boys, the idea has endless possibilities.

The Age of Radio News Items. A woman, by the expedient of not telling her age, need never grow old; and as long as journalists know little about radio, the same holds true for news items in this field. In the last few days the papers have carried headlines telling about two German ships which communicated by radio telephony over a few hundred miles; the phonograph recording of radio signals in Vienna, and the use by the New York Edison Company of a radio storm detector operated by static disturbances. The last named is about 12 years old, and the other two achievements are not so much younger.

Radio and Audio. An unfortunate man was trapped in a Kentucky cave. It was found possible to run an electric light close to him, but later the crevice through which the wires had been passed closed up, and communication with the entombed man ceased. Two newspaper men connected a two-stage audio amplifier to the wires leading into the cave, and, hearing a noise in the head-phones connected to the output of the amplifier, concluded that the captive was still alive. Although the experiment had absolutely nothing to do with radio, all the newspapers referred to the two reporters as "radio experts."

Again, an announcement appears in the papers that during an outdoor opera production at the Polo Grounds, a "radio amplification system" is to be installed. A public address system is also radio, therefore; in short, everything that comes out of a horn is radio.

Further Stirring Up of a Delicate Subject. This is written on a night in July when static is in evidence, and I have to take it just like any common listener. What we should get into our heads is that static does not accompany heat, but *changes in temperature*, and in general, those conditions that make for lightning storms. During the extreme hot wave starting June 1st, and lasting about a week, there was little static on medium distance stations, and none on locals, although temperatures far up in the nineties were the rule. It is when hot changes to cool, or when the humidity is very high, that the static tends to become rambunctious.

Statement of a manufacturer of audio transformers: "Static is diminished in proportion to the amount of volume which a radio set delivers, experts agree." This is awarded the grand prize for the month's most brilliant climax in the dissemination of radio piffle—a fresh pretzel, four and a half inches inside diameter, stuffed with highest quality garlic. An unspecified reward is also offered to every "radio expert" who will come forward and publicly "agree" with the above contribution to technology.

Notes on Chemical Plate Supply Units

An Unusually Complete Discussion of the Problems of Building and Operating a Chemical Unit for B Supply

By JAMES MILLEN

¶ *THIS article should be of great interest to the large number of constructors who are experimenting with the chemical rectifier, for it is full of the experimental "dope" which delights the heart of every genuine experimenter. While the author has given his attention especially to the problems presented by the rectifier he described, the general remarks on the chemical type of rectifier have never been presented so completely and helpfully before. The Chemical Plate Supply Unit, described in* RADIO BROADCAST *for June, has been assembled by many readers and their many letters have echoed their great satisfaction with the device. That unit can be built for about $20 and will furnish as much as 120 volts and plenty of current for any receiver.*—THE EDITOR

THE question of rectifying but half of the a. c. cycle by means of a single rectifier cell instead of the four cells for double wave rectification as described in connection with the Chemical Plate Supply Unit in June, 1925, RADIO BROADCAST, has arisen. It can be done, but the complete outfit is, in the end, larger and more expensive. Furthermore, such an arrangement will only be satisfactory when used with radio sets drawing little plate current, the upper current limit being about ten milliamperes. The increased cost and size of a single-cell plate supply over the four-cell outfit described in the June RADIO BROADCAST is due to the very much larger and more effective filter system required. In an experimental model, a total capacity of thirty microfarads and an inductance of thirty henries was used. There was no hum present in a set drawing twelve milliamperes and perhaps a slightly smaller filter might have been satisfactory. The point to be emphasized is that the filter used in connection with the four-cell outfit is not effective enough for use with a single-cell outfit. Much more capacity must be added. For the benefit of those who might care to experiment with a one-cell device, the hook-up is given in Fig. 1. The rectifier cell is identical with those used in the four-cell B battery substitute.

Another limitation to the use of a single-cell outfit is that the voltage supplied by it must not exceed about seventy volts. To increase the voltage, it is necessary to connect two cells in series as shown in Fig. 2. The double rectification four-jar unit will supply an output d. c. voltage as high as 110 or 120 volts. The reason for the higher voltage being permissible in the four cell outfit is because the total a. c. voltage is always divided between two cells. Consequently, the voltage per cell never exceeds the practical maximum limit of about eighty volts a. c.

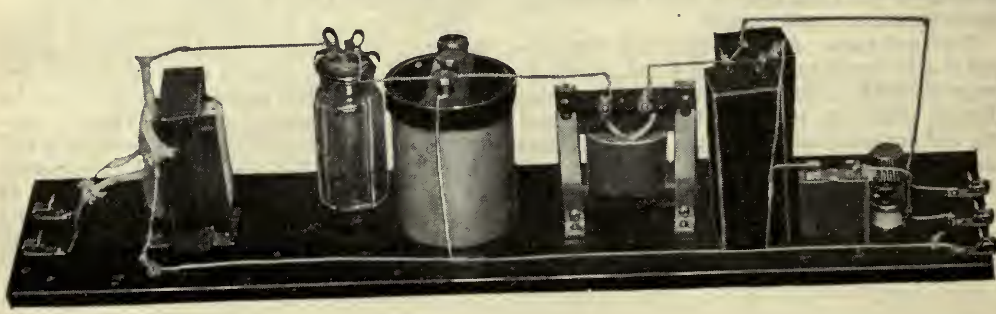


FIG. 1A
An experimental model of a current-tap with single wave rectification

INCREASING THE VOLTAGE OF THE CHEMICAL PLATE SUPPLY UNIT

A NUMBER of the readers of this magazine who are using resistance-coupled amplifiers have inquired of the writer about ways in which to increase the voltage supplied by the original unit from 110 to 150. A current-tap supplying 150 volts will require eight rectifier cells in place of four. Fig. 3 shows how they are connected. The number of turns on the transformer secondary (using $NH_3\ H_2\ PO_4$ electrolyte in rectifier jars) must be increased from 1035 to 1300. The construction of the cells, the choke, and, in fact, all other parts remains the same.

It is also possible to raise the output d. c. voltage by adding capacity to the line side of the filter. As filter condensers are rather expensive, it will be found more practical in this case to employ the method of voltage raising suggested above.

THE AMMONIUM BORATE RECTIFIER

IT HAS been found that, when a cell with ammonium borate electrolyte stands idle for a long period (a month or so), its internal resistance increases to such an extent that the output voltage of the current-tap, when again put into use, is somewhat lower than originally. This voltage will increase to normal again after about three hours' use. This phenomenon does not occur when an electrolyte of primary ammonium phosphate is used. Should the experimenter have any difficulty in securing CP primary ammonium phosphate, CP secondary ammonium phosphate may be used with equally satisfactory results.

IMPROVING THE CATHODE

ANOTHER peculiarity of the rectifier cell using an electrolyte of ammonium borate which can not be observed when one uses the ammonium phosphate electrolyte is the deterioration of the lead electrode, whose surface is oxidized to lead peroxide which crumbles off and falls to the bottom of the jar. This action is readily prevented by removing the lead electrodes after they have been used for five or ten hours, and hammering them. An old flat-iron makes an excellent anvil for this purpose. The round shape of the electrodes may be retained by rotating them on the anvil during the hammering process, or, they may be hammered until they have a square or slightly rectangular cross-section. The reason for this treatment is to force the first coating of lead peroxide into the surface of the metal and thus form a protective coating for the rest of the electrode. No more trouble will then be had with lead electrodes which have been treated in this manner. As previously stated, this deterioration takes place only when the ammonium borate electrolyte is used.

Of course this process is not necessary as it will take a long time for an untreated lead rod to be completely changed to lead peroxide powder. The real objection to the lead peroxide is that it settles to the bottom of the jar and may, in time, short circuit the two electrodes.

THE ANODES

THERE is no satisfactory substitute for CP aluminum rod for use as the anode. If one cares to take a chance with commercial rod, he may, or may not, secure a good set of electrodes the first time. The chances are that he will not. Some parts of a commercial rod are almost (but seldom) quite as good as the CP rod, while other parts of the same rod are worthless as rectifier anodes. The strange part about the commercial rod is that it appears to improve slightly with use, but it is rather poor during the first few hours. The CP rod is good from the very start.

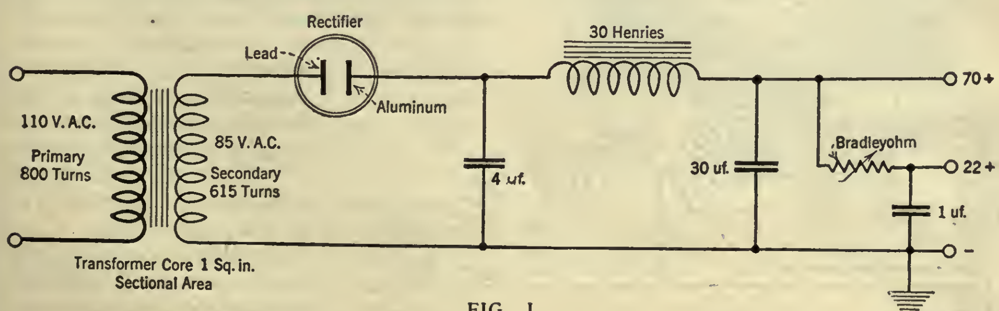


FIG. 1

The fundamental circuit diagram of the current-tap illustrated in Fig. 1 A. The transformer is not, from an engineering point of view, essential, but is required by the fire underwriters, as if it were not used and the connection to the 110-volt line reversed, a short circuit of the 110-volt line would result

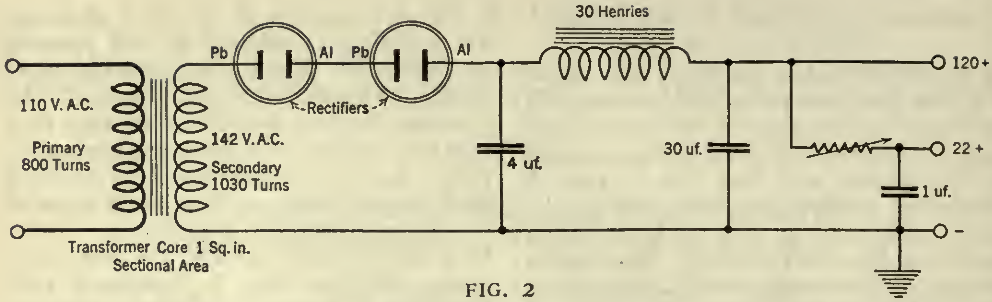


FIG. 2

When higher voltages than those supplied by the single cell outfit illustrated in Fig. 1A are required, two cells must be connected in series and the number of transformer secondary turns increased

Some tests were made using aluminum welding rods (aluminum alloyed with about 2 per cent. copper) as anodes. These electrodes were very much more resistant to corrosion when used with high currents, as in rectifiers for battery charging, but the cells employing them had quite a leakage current when used in a current-tap device. Leakage current was determined from oscillograms. The oscillogram of the output of an unfiltered chemical rectifier with CP aluminum electrodes never dropped down to the zero line, due, probably, to the filter action of the high inherent electrostatic capacity of the rectifiers. As would be expected, the d.c.-a.c. current ratio was very much better for the CP rods. Welding rods are certainly not suitable for a current-tap device.

Sheet aluminum electrodes have been used quite successfully but are not as satisfactory as CP rods. A sheet of supposedly CP aluminum obtained from a large chemical supply house was found to be impure and unsatisfactory at one end and not a bit better than the purer grade of commercial sheet.

In any event, poor electrodes are easily detected when put into use. Either the current-tap will not work properly (There is a "hum," or the d.c. voltage is much lower than theoretically calculated) or, if it appears to work properly at first, the cells will soon over-heat and then the unit will cease performing. The presence of a very soft white cloudy precipitate which seemingly floats around in the bottom third of the jar generally denotes the presence of impurities. I have never seen it in cells using distilled water and made from good materials. It nearly always occurs when tap water has been used in place of distilled water in preparing the electrolyte. As a rule, however, it does not cause much trouble, although the cells containing such a precipitate seem to run warmer than others. Always use distilled water.

FIG. 4

A pair of electrodes, showing the rubber insulating sleeve on the anode

This precipitate should not be confused with the solid crystalline deposits which are due to an excess of ammonium phosphate or borate in the electrolyte. Such precipitates are not injurious in any way whatsoever. It might be well again to warn against impurities in the electrolyte. Even the smallest quantity of ordinary table salt (NaCl) will seriously interfere with proper rectifier action.

Properly operating cells made from good materials are easily detected by observing them when operating in a dark room. The aluminum electrodes will

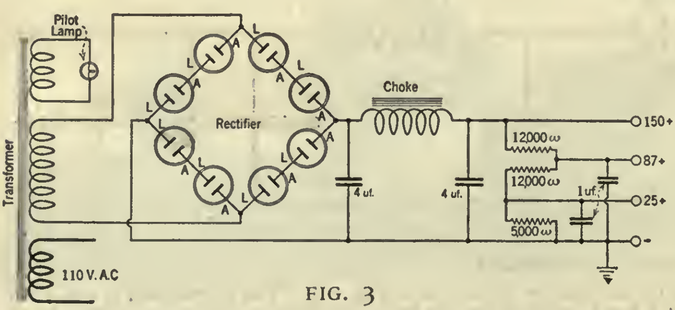


FIG. 3

The Plate Supply Unit described in the June issue may be altered so as to supply 150 volts to resistance-coupled amplifiers

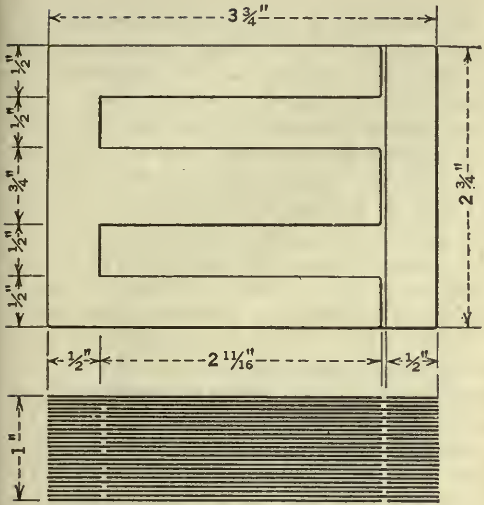


FIG. 5
Details of the shell type power transformer core

glow with a pale yellowish green light. Cells which do not so glow should be replaced.

Overheating of the cells is generally due, as previously mentioned, to the use of impure materials, but may also be caused by trying to get too high a voltage out of the unit (by increasing transformer secondary turns, etc.), The maximum filtered d. c. voltage from a four-jar unit must not be over 120 volts and should preferably be between 90 and 100 volts. The greatest allowable temperature of the electrolyte is about 50° centigrade or 122° F. As this is above body temperature, a properly operating cell may at times feel rather warm when touched.

ANODE INSULATION

AN IMPROVEMENT over the collodion film insulation for the anode as described in the RADIO BROADCAST for June is a film made from modified aeroplane wing "dope." This "dope" is prepared by desolving some celluloid (secured from old photographic negatives, etc.) in acetone. Acetone is the solvent used by motion picture operators for joining film together. It may also be obtained from any druggist. Very little is required.

A still better insulation is obtained by the use of short lengths of live rubber tubing. The inside of the tube, which should be somewhat smaller than the aluminum rod is coated with vaseline and is then stretched over the upper end of the aluminum rod and pulled down to the proper position. This insulation is, of course, put on before the rod is fitted into the stopper. The length of the electrode exposed to the solution should be one and one-half inches and the rubber insulation should extend below the surface of the liquid.

ADDITIONAL TRANSFORMER AND CHOKE DATA: THE CORES

THE transformer and choke coils are cut from silicon steel sheets of from ten to seventeen mils (thousandths of an inch) in thickness. Fig. 5 gives the shape and dimensions of the toy transformer core recommended in the previous article. As it is almost impossible to cut such shape laminations by hand, the type of core illustrated in Fig. 6 may be used. The sectional area of the magnetic circuit of the manufactured core (Fig. 5) is .75 square inches, but if a home-cut core of the type illustrated in Fig. 6 is used, the sectional area had better be one square inch. Each lamination should be given a thin coat of shellac and allowed to dry before assembling.

TRANSFORMER WINDINGS

FOR either type of core, the transformer primary winding consists of 800 turns of No. 26 enameled copper wire and the secondary of either 1030 or 1125 turns of either No. 28 or No. 30 wire.

The primary is layer wound on a square cardboard tube which fits snugly on the core. Use thin, waxed or glassine paper between layers. Several layers of heavy paper or Empire cloth are wrapped over the primary

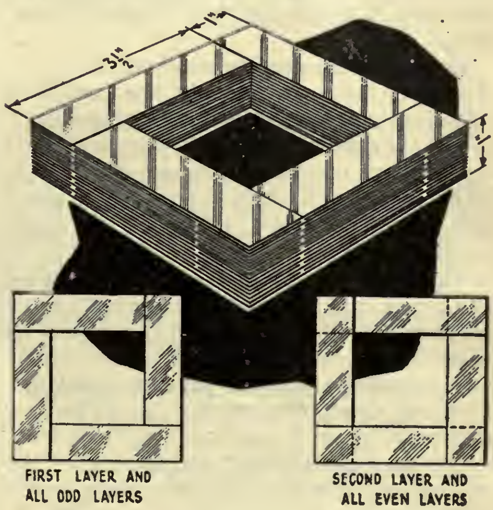


FIG. 6
If the power transformer core is to be hand-cut, the type of core illustrated in this Figure is recommended

before starting the secondary. Care should be used in bringing out the lead wires to see that they are well insulated from each other and from the core.

The choke coil core requires no air gap, as, due to the low current used in current-tap devices, the core is operated well below the saturation point.

It might interest some to know that at this time the particular current-tap shown in the illustrations in the June Radio Broadcast is still being used every day and as yet, after six months, has required absolutely no attention, not even the addition of distilled water.

The oscillogram shown in Fig. 7 was made of this same current-tap under the exceedingly heavy load of 60 milliamperes. Fig. 8 shows the effect of insufficient capacity in the filter system.

WHAT AN OSCILLOGRAM IS

AN OSCILLOGRAM is a visual indication of how current or voltage, as the case may be, varies with time.

A variation in the output of a double-wave rectifier, which is operated from 60 cycle a. c. would be very noticeable in the loud speaker of a receiving set, in the form of a 60-cycle "hum." This "hum" would usually be indicated by the periodic variations in current as indicated by the curved line in Fig. 11. The time interval between peaks is $\frac{1}{60}$ of a second. Current at any instant is proportional to the vertical distance of a point on the curve from the straight horizontal "zero" line.

In Fig. 7, the current is steady, as shown by the upper horizontal straight line, and as a result, no hum is heard in the "loud speaker."

The allowable periodic variations in the current is about 1 per cent. although some people do not object to a "hum" caused by as much as 5 per cent. current variation. This latter condition is approximated by Fig. 8.

Oscillograms, such as those accompanying this article, are made by a photographic process in which a fine beam of light is caused to move up and down with variations in current on a strip of photographic paper mounted on a revolving drum, thus tracing the white lines shown in Figs. 7, 8, and 11.

The neat and compact arrangement of the rectifier jars shown in Fig. 9 was made by one of the readers of Radio Broadcast, Mr. F. A. Dede. The jars and electrodes are similar to those used in the original outfit. The straps around the top and bottom are made of zinc, although any other material would have been just as suitable. The top is sealed with battery wax, which may be obtained from any storage battery service station. Four Fahnestock automobile ignition cable clips are used on the four electrodes to which connections are made. All wires between cells as well as the tops of the four electrodes not fitted with clips are concealed in the wax. Two small glass vent tubes are provided for each cell, one for filling and the other for the escape of air in the jar while it is being filled. The electrodes were held in place by means of cardboard discs fitted into the necks of the salt-mouth bottles. The hot wax was then poured over and allowed to harden. The cardboard discs also preventing the melted wax from running down into the bottles. The Fahnestock clips facilitate the easy removal of the rectifier as a unit from the current-tap cabinet for occasional inspection and addition of distilled water.

While describing unit arrangements of cells, it is well to emphasize the fact that the jars must not be completely sealed in a small box or other such container which would seriously reduce the heat radiation and thus cause the temperature of the electrolyte to rise. The arrangement shown in Fig. 9 does not violate this rule as air can circulate around each cell.

The majority of commercial B battery substitutes, especially those employing vacuum tubes as the rectifiying units, show an unfortunate drop in voltage with increased loads. Thus the voltage supplied to a single-tube set by such a device might be nearly one-hundred volts whereas the voltage supplied by the same unit to a superheterodyne without proper C batteries might be but thirty or forty volts.

Such trouble is not had with the Chemical Plate Supply Unit as the drop in voltage due to increasing load is slight owing to the relatively low internal resistance of the chemical rectifiers. This phenomenon is illustrated by the curves in Fig. 9. Curve A is for a commercial B battery substitute using a UV201A tube, while curve B is for the Chemical Plate Supply Unit described in the June Radio Broadcast.

THE EXPERIENCE OF A READER

MR. R. E. GRAVES, in the following letter, gives some information which may be of value to those who have built the Chemical Plate Supply Unit described by the author.

Referring to the B battery substitute described in your June issue, I have recently made one, and the results it gives are excellent. However, for your information and to help you in answering inquiries, I will give you the following information,

Instead of following out your transformer specifications, I had the Thordarson Elec. Mfg. Co. of this city, make the transformer which steps 110 volt a. c. up to 150 volts, but I found that with this high voltage the aluminum will not hold its film and it was necessary to put a resistance in the input to give me an output of about 125 volts.

The transformer has an extra winding for a 6-volt automobile lamp.

These people carry a 30-henry choke coil wound with large wire which I found very good. Instead of purchasing salt mouth bottles I bought four B battery chargers at the ten cent store. These come complete with rubber screw tops and the lead and aluminum rods.

Below is the cost of the special parts:

Thordarson Transformer . . .	$6.00
" Choke	4.00
Rectifier jars complete	.25 each

Primary ammonium phosphate can be purchased in Chicago from Schaar & Co. 556 W. Jackson Blvd.

The transformers specified in your June issue are not to be found in Chicago.

The price of salt mouth jars and accessories if purchased here would put the rectifier cost to about $3.00 as compared to $1.00 if bought at the ten cent store while the primary ammonium phosphate can be purchased at only two places in Chicago and I might add that the amount of phosphate as specified in your article did not make a fully saturated solution.

I am very pleased with the outfit, although from the start I knew that it would work or it would not have been published in RADIO BROADCAST.

Respectfully yours,
R. E. GRAVES.
Chicago, Illinois.

FIG. 9
A compact way in which the four rectifier cells may be combined into a single unit

FIG. 7
Even when an exceedingly heavy current (50 milliamperes) is taken from the Chemical Plate Supply Unit described in the June RADIO BROADCAST, the output is very well filtered as shown by the smooth oscillogram of the output

FIG. 8
This oscillogram is a visual indication of what occurs when the constructor attempts to economize in the construction of the filter by using a total electrostatic capacity of 4 microfarads rather than eight. The load here is adjusted for a current of 60 milliamperes

WHERE SUPPLIES FOR THE UNIT CAN BE SECURED

AS MANY of our readers have written that they have been unable to secure the chemical supplies listed in the June RADIO BROADCAST at reasonable prices, we have investigated the situation further and found that the material may be obtained from the following concerns:

Empire Laboratory and Supply Co., Inc.,
218 East 37th Street, New York
Strahs Aluminum Co.,
48 Franklin Street, New York
Aluminum rods only

The prices for the complete set of parts as listed below range from a high value of $2.61 to a low value of $1.75:

FIG. 11
Due to the high inherent electrostatic capacity, the unfiltered current supplied by a double-wave electrolytic rectifier does not drop to zero

4 3 oz. salt mouth bottles.
4 No. 6 rubber stoppers
1 2-ft. length $\frac{5}{16}$" diameter CP Aluminum rod.
1 2-ft. length $\frac{5}{16}$" diameter lead rod.
1 6-inch length glass tube for vent
1 oz. primary or secondary ammonium phosphate.
Any of the individual items may also be obtained separately.

As the price of lead rods still seems most unreasonable when obtained from chemical supply houses, the cathodes should be made from sheet lead which is readily obtainable at a very much lower price from your local plumber. Such lead should be cleaned with sand-paper before using.

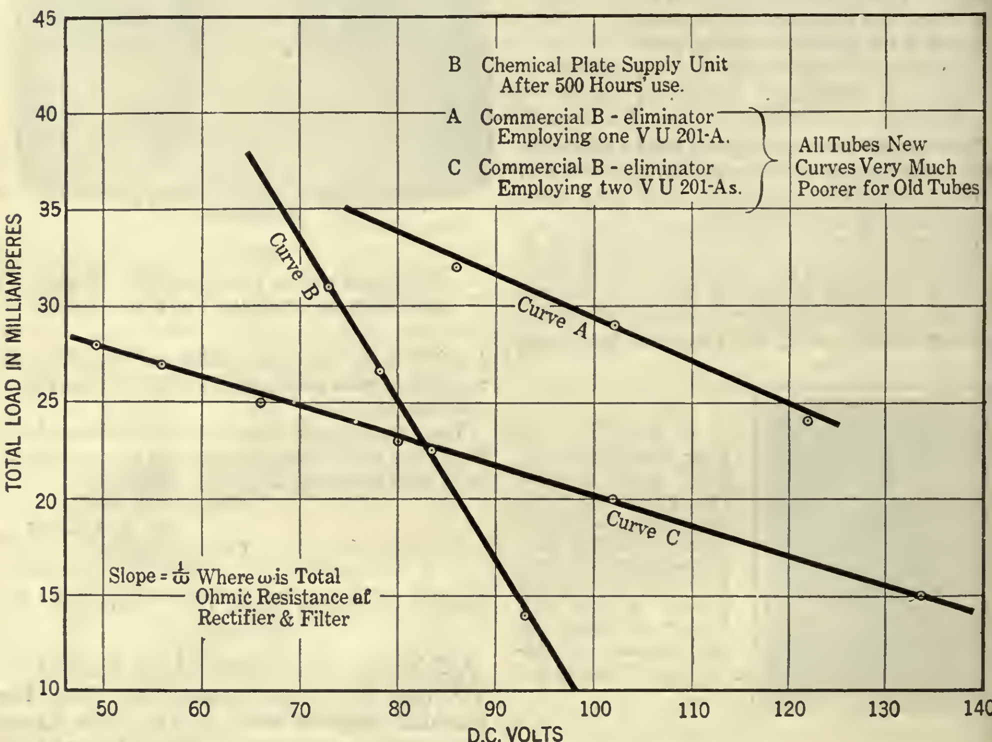


FIG. 10
These curves show how the voltage supplied by several different types of current-taps, drops as the load is increased

Single-Control For Your Present Receiver

A Geared Condenser Unit Which Can Be Applied to the Roberts Knockout, the Phonograph Receiver, the Browning-Drake, the Super-Heterodyne, and Many Other Popular Receivers

By ALLAN T. HANSCOM

¶ THE methods so far brought out for single-control of radio receivers have all been those which used a group of condensers all tuned by one dial—which simultaneously varied the frequency (wavelength) of each circuit in which the various condensers were connected. This method, due to Hogan, is quite workable, but it allows nothing for variations in the individual coils in the circuits. The unit described here may be applied to any circuit in which two coils of approximately the same value are tuned by condensers. Due to the ingenious cam arrangement on the first condenser of the single-control unit described in this paper, any irregularity in the first secondary coil of the circuit to which this unit is applied, may be compensated for by a preliminary adjustment of the first condenser. This is not a how-to-make-it article but the elements of the device are standard. The mechanical features of the complete unit could only be made by a constructor with more than ordinary mechanical ability and a good machine shop at his command. The single-control element should prove so helpful to the home-assembler that we feel no hesitancy in publishing this article, although the unit cannot be made, but must be bought.—The Editor

THE necessity for selectivity in radio receivers is becoming more evident as more stations take the air, and radio listeners will probably welcome a more simple method of tuning which will not in any sense detract from the efficiency of their receivers.

The ultimate in receiver design should have one station selector, one control for volume and one control to turn the set on and off. The old single-circuit receiver approached these requirements but did so at the expense of the selectivity which is an urgent requirement nowadays. The single-circuit set radiates most distressingly and so it has been gradually superseded by sensitive receivers of more desirable types.

Practically the only possible way to secure selectivity in the receivers in general use to-day, is by means of two or more tuned circuits. Now, since each circuit must be tuned separately, we have two or three tuning controls on most of the receivers now popular. It was early apparent that this difficulty could be overcome, provided the two or more tuned circuits could be controlled simultaneously with a single knob or dial. To do this successfully required laboratory methods which can not be adopted by the average constructor, and—more important—do not go hand in hand with quantity production in manufacturing.

With these ideas in mind, the writer has developed a method which permits of the simultaneous tuning of two circuits, and at the same time makes possible a slight variation of one circuit without disturbing the other, in order to compensate for slight variations in the two.

This makes the reduction of one tuning control possible, and in the case of the standard neutrodyne or other tuned radio frequency receivers, the number of controls is thus reduced from three to two. In sets using a single stage of tuned radio frequency, such as the Radio Broadcast three- and four-tube Knockouts, the Browning-Drake, etc., as well as most super-heterodynes, the number of tuning controls is reduced to one, and the simplicity of the tuning is a pleasant surprise to a person operating one of these sets for the first time.

The essential feature of this assembly consists of two Remler condensers mounted in such a manner that their capacities may be simultaneously varied with a single Marco dial reading through 180 degrees. In addition, one of the condensers may be varied through 20 degrees of dial movement without disturbing the setting of the other condenser. At the mid-point of the vernier setting, the two con-

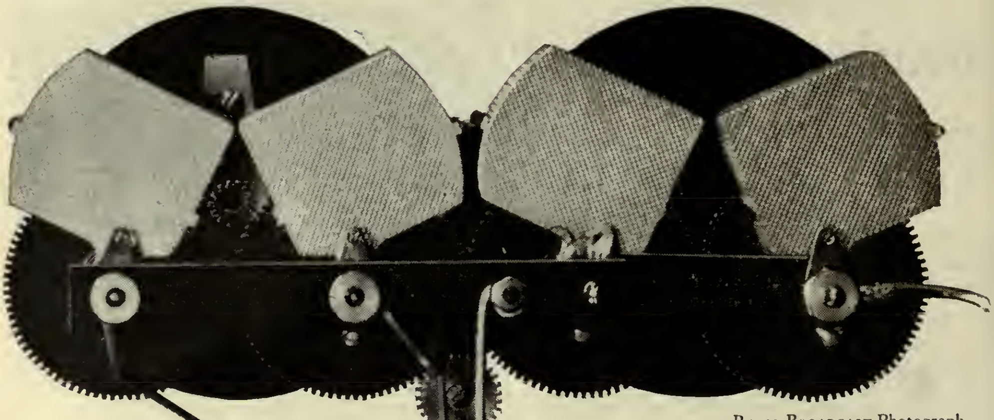


FIG. 1

Radio Broadcast Photograph

The gearing arrangement of the two Remler Condensers is clearly shown in this rear-view photograph. The dial shaft gear can be seen in the center between the two pieces of bus-bar. The cam controlling the vernier motion of the right hand condenser is not included in the photograph

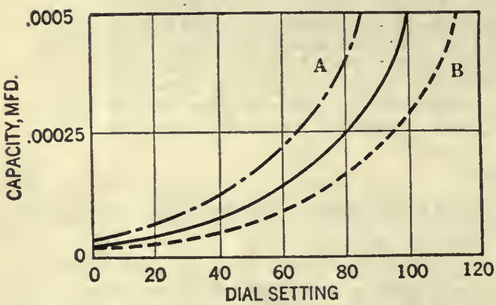


FIG. 2

The curve in the center shows how the capacity for one condenser will increase or decrease with respect to the dial readings. The dotted curves, A and B, depict how the values vary as the vernier is adjusted between maximum and minimum points

densers have equal capacity at any dial reading and the vernier gives a plus or minus variation sufficient to cover the ordinary inequalities of tuning. This arrangement has the following important advantages:

1. Dial may be logged.
2. Straight line wavelength curve of the condenser spreads stations evenly on the dial.
3. Vernier variation at any setting is proportional to wavelength.
4. The main dial and vernier not electrically connected, thereby avoiding hand capacity effects.
5. Condensers each have separate terminals and may be connected independently.

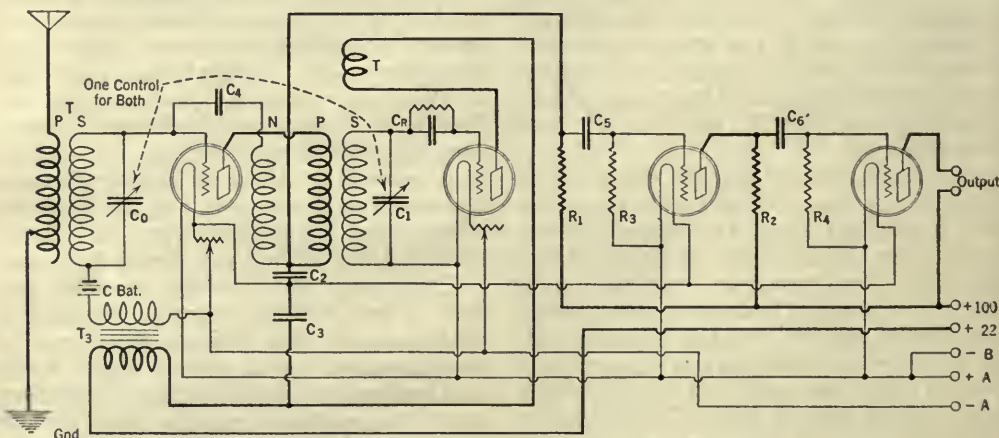


FIG. 3

The application of the single-control feature described in this article, may readily be applied to the Roberts Knockout receiver, a diagram of which appears above

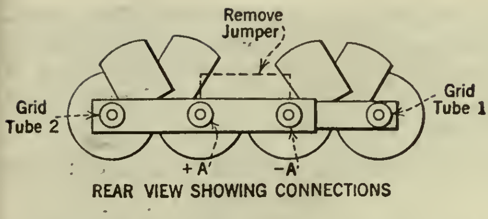


FIG. 4B

If the idea suggested in Fig. 4A. is tried out, the fan can follow the connections marked in this diagram for the two condensers

6. Side-by-side mounting saves space and conforms to layout of set.

The applications of the single control capacity element to various circuits will be taken up at length, and a description of the device is first presented in order that the details may be made clear. From the photographs we see that the two condensers are mounted so that the gears will engage with each other and consequently the rotation of one condenser will affect the other one simultaneously. The dial shaft gear is shown in Fig. 1. This drives the left hand condenser which in turn is geared to the one on the right. The cam which controls the vernier motion of the condenser on the right can be seen in the photograph of the back of panel view of the four-tube Radio Broadcast phonograph receiver. The condenser is mounted so that it may be raised or lowered by the motion of the cam and yet the position of the gear which engages with the left hand condenser remains fixed. If the main dial shaft is rotated, both condensers will be affected; but the motion of the shaft containing the cam will vary the capacity of the right hand condenser but will in no way affect the one on the left. Fig. 2 represents the curve of one condenser and if the vernier is set at the mid-point, the other condenser will have an identical curve. In Fig. 2, A represents the curve of the right hand condenser with maximum adjustment of the vernier, while B in Fig. 2 represents the minimum adjustment.

In the application of this device to a receiving set, it is necessary to bear in mind certain

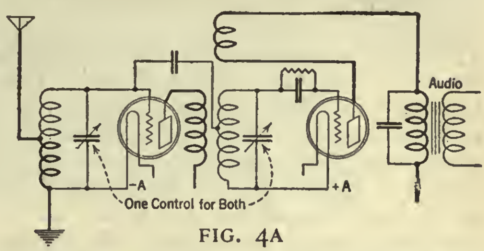


FIG. 4A

The Browning-Drake and Silver circuits, which are almost identical, have two variable condenser controls, and it is possible to cut this down to one control by employing the system outlined by Mr. Hanscom

fundamentals which apply to tuned circuits. For a given frequency (wavelength), a certain value of C (electrostatic capacity) must have a definite value of inductance, the frequency, (wavelength) being a function of the product of these two. If we increase the

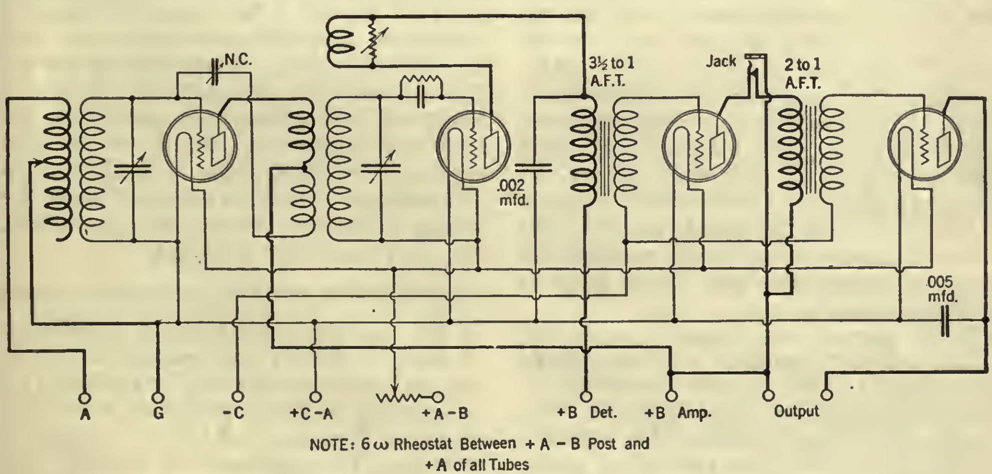


FIG. 5

The single control unit may readily be applied to the Radio Broadcast Phonograph Receiver. In this way only one control will be necessary for the condenser shown across the secondary tuning coil and that across the secondary of the r. f. transformer. The connections in Fig. 4B apply in this instance also.

inductance we must decrease the capacity in order to tune to the same frequency (wavelength) value. It should therefore be apparent that, if two circuits are going to be tuned with this capacity element, the inductance of each circuit should be approximately equal. When these inductances are equal, it will be found that the adjustment of the vernier is unnecessary throughout the entire frequency (wavelength) range, but the vernier makes possible the necessary correction for differences in inductances and distributed capacity of the circuits.

APPLICATION TO THE ROBERTS KNOCKOUT RECEIVER

FIGURE 3 represents the Roberts circuit, which consists of a stage of tuned, neutralized, radio frequency amplification and a tuned detector with tickler feed-back together with a stage of reflexed audio amplification. As applied to this circuit, this single-control capacity element should be connected so that the condenser which is controlled by the vernier will tune the first radio frequency stage. It is suggested that a small fixed condenser be connected between the antenna and the tap on the first tuning coil, particularly if the set is used with a long antenna. If the single-control device is applied to a Roberts Knockout set which is already in use, it is well to make the necessary adjustment in order that the two dials will read alike before the element is installed. If you find, for instance, that the antenna tuning dial is always lower than the second dial, this should be corrected by inserting a small fixed condenser, from .0001 to .00025 mfd. in the antenna lead. If the dial still tunes low, this may be corrected by removing a few turns from the antenna tuning coil. This is necessary only in extreme cases, and if the dials can be made to read within four or five points of each other, you may install the single-control without any change in the set. In most Knockout, receivers this change is brought about by means of the antenna switch, which compensates for antennas of various lengths.

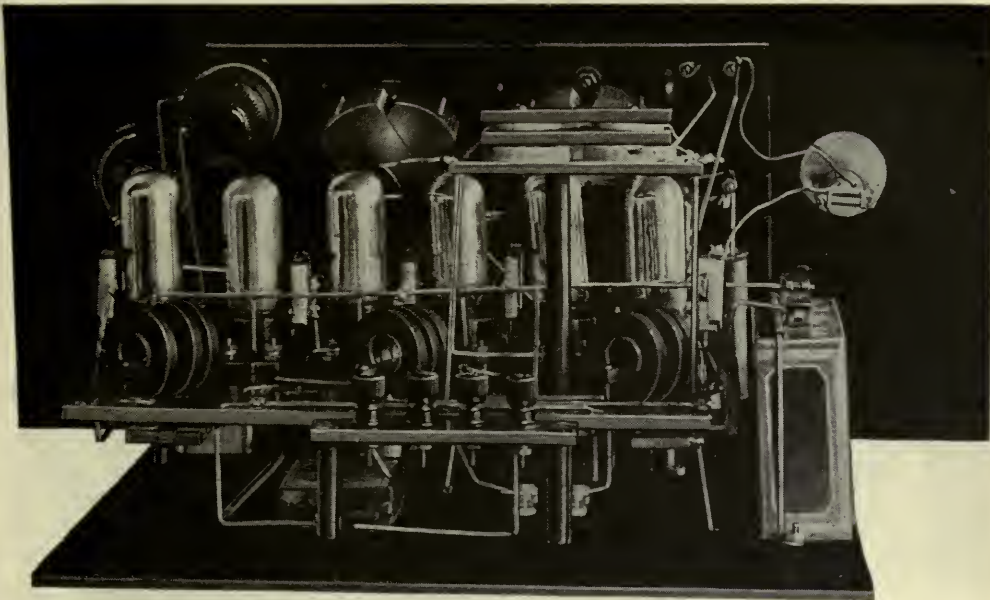
It is suggested that the plates of the two condensers which are nearest each other, should be connected to the filament end of the respective coils to avoid coupling effects. The single-control capacity element has a flexible connection between these two sets of plates, and in the case of a positive return to the detector filament, this connection may be removed and the wiring then made in the usual manner care being taken to supply flexible leads to the left hand condenser. The single-control capacity element is mounted on the rear of a panel by means of three screws and nuts, and the template gives the location of all the necessary holes.

SINGLE-CONTROL FOR THE BROWNING DRAKE RECEIVER

THE Browning-Drake receiver (completely described in RADIO BROADCAST for December, 1924), is deservedly one of the most popular circuits in use to-day, and it has earned this popularity through the excellent results which are obtained with it. This circuit differs from the Roberts only in the method of neutralization and in its lack of reflexing. Some of the kits which are on the market for its construction are provided with a .0005 mfd. variable condenser for the first stage and a .00035 mfd. condenser for the second stage. This results in the left hand dial reading lower than the right, particularly on the lower frequencies (longer wavelengths). In most cases however, the single-control capacity element can be installed in the regular manner. If it is found that the vernier must be turned to the extreme position so that the first condenser has more capacity than the second for any given setting, this may be corrected by lengthening the antenna or by connecting it to a tap on the coil a few turns nearer the grid end of the winding. If it is found that the vernier works best in the other extreme, where the first condenser has less capacity than the second, it can be corrected in one of three ways. One can shorten the antenna; connect a fixed condenser .0001 to .00025 mfd. capacity between the antenna and the tap on the first coil, or move the tap on first coil nearer the filament end. It will be found that the original inequalities can be taken care of with the vernier, but bear in mind that the proper adjustment of these inductance and capacity values will make the vernier almost superfluous, leaving only one, frequency (wavelength) control.

SINGLE-CONTROL FOR THE SUPER-HETERODYNE

THE super-heterodyne circuit consists essentially of two tuning controls, one to adjust the loop or antenna coupler and the other to vary the oscillator frequency, the latter to produce the proper beat for the intermediate amplifier. The single-control capacity element lends itself admirably to this type of circuit, because the proper value of loop inductance may be obtained by using the proper size and number of turns on the loop. To do



RADIO BROADCAST Photograph

FIG. 6

This illustration depicts the second harmonic super-heterodyne described by Mr. Hanscom in the November, 1924, RADIO BROADCAST. The single-control capacity element has been found ideal under actual working conditions, in this type of receiver

this, it is only necessary to vary the loop turns until a point is reached where the desired frequency (wavelength) range can be covered with the least possible variation of the vernier. The super-heterodyne is different from the tuned radio frequency set in the respect that it depends for its proper action on the constant difference of frequency between the two tuned circuits. It is, therefore, only necessary to provide the same tuning range in each of the circuits and the vernier can be set so that one condenser will always provide more capacity than the other, thereby providing the desired beat frequency. It is possible to calibrate a super-heterodyne for either the upper or lower setting of the oscillator. Below is given the dial settings of a two-dial super-heterodyne with a given loop.

	LOOP	OSCILLATOR
1199 kilocycles (250 meters)	8	$11\frac{1}{2}$
999 kilocycles (300 meters)	16	24
833 kilocycles (360 meters)	27	$38\frac{1}{2}$
750 kilocycles (400 meters)	$33\frac{1}{2}$	48
600 kilocycles (500 meters)	51	73

This shows a total dial movement between the limits specified, of 43 points for the loop tuning and 61 for the oscillator. To correct this, three turns were removed from the loop after which the readings were as follows:

	LOOP	OSCILLATOR
1199 kilocycles (250 meters)	$13\frac{1}{2}$	$11\frac{1}{2}$
999 kilocycles (300 meters)	$24\frac{1}{2}$	24
833 kilocycles (360 meters)	39	$38\frac{1}{2}$
750 kilocycles (400 meters)	50	48
600 kilocycles (500 meters)	75	73

It will be noticed that there still exists a considerable difference in the dial readings, but the total scale movement for each condenser is the same, and the vernier adjustment may be set at a position which will give uniform results throughout the entire scale. On practically all super-heterodynes the oscillator tunes sharper than the loop, and the single-control capacity element should be connected so that the right hand condenser will tune the oscillator, leaving the vernier for the fine tuning adjustment on the loop.

SINGLE-CONTROL FOR THE RADIO BROADCAST PHONOGRAPH RECEIVER

THE popular Roberts Knockout circuit is the basis of the set which has been featured by this magazine as being the best receiver for the money that can be built by the home constructor. By utilizing the capacity element, a phonograph receiver can be constructed as a true one-control set. A simple receiver, made to specifications supplied by RADIO BROADCAST and incorporating this de-

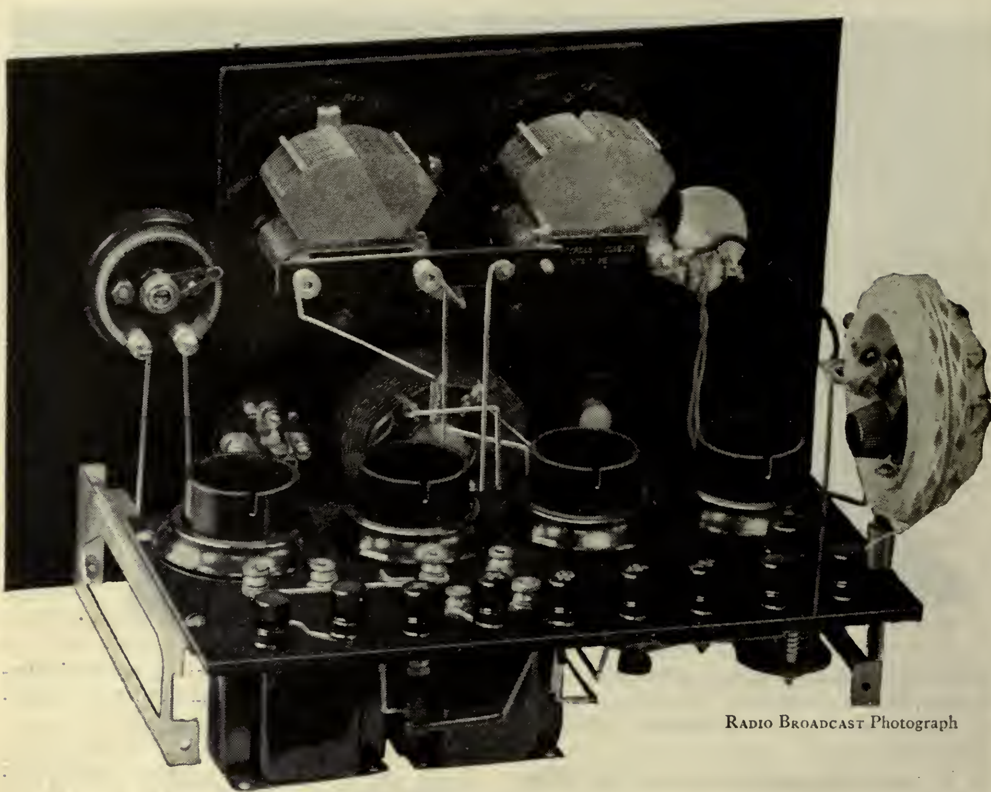


FIG. 7

A variation of the Radio Broadcast Phonograph Receiver employing the single control capacity element. The cam which controls the vernier action of the condenser on the right, is shown beneath that condenser and is partly hidden by the detector tube socket. A Claratuna unit is employed for the r. f. coupling. This unit comprises a radio frequency transformer to which is tightly coupled the tickler coil. Regeneration control is accomplished by a variable resistance incorporated within the Claratuna

vice, is shown in the photograph. There are four tubes, consisting of one stage of tuned radio frequency, detector, and two stages of audio. The front panel measures only $12\frac{3}{8}$ by 8 inches and the sub-base measures 5 by 10 inches. This is supported to the front panel by means of Benjamin brackets. The binding posts are mounted along the rear of the sub-panel and the Thordarson audio transformers are fastened beneath it. The Sickles antenna coupler contains a four-point switch to compensate for various lengths of antennas, and the coupling element between the radio frequency tube and the detector is a coil with fixed tickler, known as the Claratuna, mounted beneath the tuning element. The regeneration is controlled by a carbon resistance shunting the tickler coil. This gives a smooth even control without the necessity of moving coils, the space required for the radio frequency unit being reduced to minimum. This receiver gives excellent volume, distance and selectivity, and the simplicity of tuning is a revelation.

Fig. 5 shows the wiring diagram of this phonograph receiver. The negative filaments of all tubes are connected together and to the ground. Use of the complete antenna coupler and the coupler between the first and second tubes, makes the wiring of the set a simple matter. The audio transformers are mounted with the cores in line and not at right angles, and the metal shieldings of the transformers are connected together and to the ground. A Chelten Midget condenser is used for neutralizing and its position is not critical. It is located on the sub panel at the end nearest the antenna coupler, which is clearly shown in the photograph.

EDITOR'S NOTE

THE opinion is prevalent among some broadcast listeners that the use of straight line frequency, or wavelength, condensers will relieve most of the present difficulties in tuning. There are cer-

tain things that these condensers will do, and naturally others that they cannot do. What the phrase, straight line condenser means is that a given number of degrees on the condenser dial represents a certain number of kilocycles, or wavelengths, regardless of which end of the scale is being used. This is of distinct value at the higher frequencies (lower wavelengths) and will enable the user to distinguish many of the stations now in class A. Condensers of this type will not eliminate the heterodyning of two stations that stray from their assigned frequencies; they will not separate two stations that are on the same frequency, as many in Class A are, and they will not eliminate any of the tuning troubles that arise at the transmitting station.

RADIO BROADCAST Photograph

FIG. 8

A front-of-panel photograph of the receiver shown in the preceding diagram. The apparatus on the panel, reading from left to right, include a voltmeter, the single-control dial, rheostat, and (bottom row) vernier control knob, resistance control and phone jack. A Hoyt filament voltmeter is included, and the use of filament meters is recommended in all receivers. Operating tubes above their rated voltage very materially decreases the life of a tube

The New Size of "Radio Broadcast" for November

WITH the November number, RADIO BROADCAST will be three and a half years old. During its career the publishers have tried, through every means in their power, to produce a magazine which, from the reader's point of view, should take the leading place in the radio field. Judging from letters which from time to time trickled into our office—letters of gratitude from our readers, backed up by healthy circulation figures, it appears that we have not failed altogether in this respect. It has been our constant endeavor to make the word "quality" synonymous with both our editorial and advertising contents. Now, it is not our custom to celebrate a birthday every six months, but nevertheless it happens that in November, we shall signalize the occasion by introducing RADIO BROADCAST in a new form. The public support and approval of the magazine has been so unqualified that its physical size and appearance must be improved in addition to the improvements which from time to time we are constantly effecting in the editorial pages. November fifteenth, 1925, will be our red letter day then, and we hope that our readers will, by their universal

approval, help us to celebrate the occasion when the new Radio Broadcast appears. We contend, and that is only because our readers contend too, that our contents are exactly what the readers desire, and it is for this reason that every one of the popular features of the present magazine will be retained in the larger size.

Our constructional articles, as most of our readers know, are not printed merely because they provide another way to build a receiver, or worse still—because they afford another outlet for parts. The criterion by which we judge our construction articles is: *first*, are they authoritative? *second*, are they helpful? *third*, do they provide information on construction which is not available elsewhere? *fourth*, are they complete? These aims, we think we have attained. Our readers tell us we have done so, and after all is said and done, it is the reader who is in the most advantageous position to judge.

The authors who write for Radio Broadcast are men who know what they are writing. They are in the best positions to obtain information . . . shall we call it dope? . . . which is most interesting to our readers. Their names are veritably ones to conjure with in the vast field of radio. Ever since the first number of the magazine was placed on sale, it has contained, month by month, that engrossing article "The March of Radio" specially prepared by Professor J. H. Morecroft, of Columbia University. This editorial record of radio progress, which nearly everyone of importance in the radio industry reads, will naturally continue in the new Radio Broadcast. Mr. Morecroft occupies a high position in radio; a Professor of Electrical Engineering at Columbia, a Past President of the Institute of Radio Engineers, and author of a standard text on radio, *The Principles of Radio Communication*, Mr. Morecroft has a weight of knowledge and authority behind his editorial comment, which is nationally quoted every month.

Then there is Carl Dreher, one of the most able broadcasting engineers in the country. He tells us monthly what the broadcasters are doing and how they are doing it, and in his inimitable fashion—which has won him recognition in other fields than his chosen one—relates the opinions and comments that are prevalent, about the latest developments in the radio field.

The broadcast listener is represented in that popular feature "The Listener's Point of View," which has, again judging from correspondence alone, a very large following. We aim to cater to the fan of every stage, from the veriest of embryos to the most technical of them. For the former, Zeh Bouck conducts a department calculated to interest the beginner but written interestingly enough to be followed by the more technical man. He sets out to guide the beginner sympathetically and carefully through the early and confusing mazes of radio, and in this he succeeds admirably.

And as regards advertising. The high standard of admissibility to our columns is the reader's assurance that everything advertised is exactly as it is described. Our policy is first to be sure and then go ahead. For that reason the star of approval, appearing on all the advertising pages, was established many months ago. It is a way of telling our readers that the apparatus advertised has been given a thorough test by the laboratory and was found satisfactory. The man not behind the editorial scenes cannot realize what an effort it has to maintain strictly this advertising policy under all conditions, but we feel sure that we have not failed in this respect. Our laboratory, we might add, is, in technical equipment and staff, second to none in the country.

In addition to its new size, which, by the way, will be eight and five eighths by ten and a half inches, the magazine is to be printed on a more expensive paper, a heavy white paper, which will greatly enhance the appearance of the illustrations and make the diagrams even clearer than is possible at present.

A NEW COVER

A PRIZE of $500 was offered for the best cover design for the new magazine, and one has been chosen by the judges, which we think our readers will agree is particularly pleasing and attractive. It was painted by Mr. Fred J. Edgars of Tenafly, New Jersey, and was picked from innumerable others submitted from cities all over the United States.

In the November Radio Broadcast we are planning some features of particular interest. Robert H. Marriott, the first president of the Institute of Radio Engineers, has written a fascinating story of radio development, which will be run serially. Keith Henney will continue his engrossing articles on "What Is to Become of the Home Constructor," and there will be more phonograph radio receivers for those interested, in future issues. There will be an article on a high quality audio amplifier which operates direct from the a. c. mains; latest information on short wave work, gleaned from the operators of Radio Broadcast station 2 GY; plans for the third International Radio Broadcast Tests, and a host of important constructional material exclusively written for this magazine.

In November, Radio Broadcast will greet you, bigger and, we are sure, better than ever.

High Radio Adventure—On Short Waves

The Romance of Code Communication Far Below the Broadcast Channels—Something About RADIO BROADCAST'S Experimental Transmitting Station 2 GY

BY KEITH HENNEY

Director, RADIO BROADCAST'S Laboratory

FOR some months, the RADIO BROADCAST *Laboratory has been hard at work—among its many other activities—in installing a high frequency (short wave), low powered transmitting station to operate in the communication bands assigned to amateur experimenting. The field of high frequency (short wave) transmission offers one of the most fascinating fields for experiment in all radio—as any amateur operator will tell you with a sympathetic optical twinkle. We have no desire to encroach on the field already well covered by our excellent contemporary, QST, and on the work we expect to do will be along somewhat different lines—although none the less fascinating. In an early number of the magazine we shall have an announcement of very great interest about this work and our station,* 2 GY. *A goodly number of advanced broadcast listeners, if we are any judge, are becoming more and more interested in what is being done on other communication bands than the broadcasting and this article presents some of the romance and interest of that new territory for radio exploration.*—THE EDITOR

ADVENTURING into the radio region below about 1500 kilocycles (200 meters) is like exploring unknown territory. It is impossible to say what will be found there and no guess is too wild. From this frequency, 1499 kilocycles to be exact, down to goodness-knows where, is a region so vast that all existing stations could be placed in it without crowding. "DX" exists there that is undreamed of on the longer waves, and it is a territory into which any one may venture with the certainty that he will discover interesting things.

A few years ago there were no stations working between the amateurs and the commercial stations operating on 1499 and 499.7 kilocycles (200 and 600 meters) respectively. Then the broadcasters filled the gap and gradually moved down toward the "hams" until they are now next-door neighbors. The amateurs, by government fiat, moved down into the "no man's land," employing frequencies of from 1499 kilocycles up (200 meters down).

Leon Deloy of Nice, France, an enthusiastic amateur experimenter, is one of the individuals who really started the short wave affair going on a grand scale. Sporadic attempts had been made to entice amateurs into this territory, but when this Frenchman established communication across the Atlantic on a frequency of about 3000 kilocycles (100 meters), it was the signal for great amateur activity with the short waves that had once been thought useless. Now the amateurs not only occupy a band from 1999 to 1499 kilocycles (150 to 200 meters), as of old, but they are working in bands around 3748, 7496, 14,991, 59,964, 428,314 kilocycles, (80, 40, 20, 5, and .7 meters).

After Deloy's success it was not long until England, Denmark, and The Netherlands amateurs had communicated with America, and now there are few civilized nations whose radio citizens are not in personal touch with other foreign countries.

Below 1499 kilocycles (200 meters) is a paradise in which nationality, language, and distance are of no importance, nor is a limited pocketbook an excuse for staying away from the most interesting region of radio. There is the record of the Massachusetts boy who spoke with a fellow amateur in Australia with a lone 5-volt receiving tube which cost him $3.

Remember how few stations you can hear on your broadcast set in the summer time at night—and how very few in the day time. Now suppose you sit in with the operator of 2 GY, the experimental transmitting station operated by the RADIO BROADCAST Laboratory.

AN AIR TOUR

IT IS Saturday, June 27th. The weather is not particularly favorable. At 9:40 A. M. we tune the receiver to 7496 kilocycles (40 meters) and at 9:43 we hear 8 NX, Walter J. Barnwell, Lansing, Michigan, calling. We converse with him until after 10 o'clock when he says that our signals are somewhat wobbly, probably due to weather conditions between the two stations. At that time we hear 9 EK, the Burgess Laboratories Station at Madison, Wisconsin, calling us, and for the next hour we try to get together without success. He cannot hear us and his signals waver too much for comfortable reception.

At 10:58 we hear WNP, S. S. *Bowdoin,* Commander MacMillan's vessel sending a long message to 1 NT, Norman C. Theobald, Attleboro, Massachusetts. We copy all but two words and when the *Bowdoin* has difficulty in hearing 1 NT, we step in and call him ourselves. He is troubled with near-by interference and finally replies 2 NY instead of 2 GY so we are not sure that we worked him after all.

Not long after, 9 EK calls us again, and after some attempts to get together he broadcasts

FIG. 1

The installation at 2 GY showing the 50-watt transmitter, receiver, wave-meter, and batteries for plate voltage. Strangely enough the "5 watter" transmitter operating entirely from batteries so far has done about as good work as the big transmitter. The big set requires 130 milliamperes, the small one, 60 mils. The receiver was made by U. B. Ross of 2 UD, and the wavemeter constructed to Bureau of Standards specifications. Although the map doesn't show it, there are pins in California and Dakota

a message to our Chief, Mr. Frank N. Doubleday. It says:

Greetings from Burgess Organization via our two stations. Hope to coöperate with Lynch to aid short wave work.

After telephoning the MacMillian message to the Western Union for transmission to the National Geographic Society at Washington, we sign off for luncheon. MacMillan, at that time, had just left Nova Scotia, and was on the second lap of his polar journey.

The next day, Sunday, June 28, we arrived at the station at 6:25 A. M. to see what was going on at that hour. It is raining slightly and there is some static. The first thing we hear is 6CHZ, Wallace S. Wiggins, Los Nietos, California, calling NPO. Now NPO, if you please, is Guam Island, in the Northern Pacific (6000 miles from California). At 6:39 we hear 6BUR, L. E. Smith, Whittier, California, 6CGW, K. L. Riedman, Long Beach, California, and 5UK, Charles A. Freitag, New Orleans, all working. A minute or so later we hear a strange note pounding away at great rate working with 2MU, William Schick, Brooklyn. It turns out to be NVE, U. S. S. *Utah*, bound from Panama for San Pedro and now off the coast of Lower California. He has a load of Annapolis midshipmen aboard. Turning the tuning dial a bit we stumble into NPM, Honolulu, calling NPN, Cavite, Phillippine Islands. At 7:25, one hour after we arrived at the station, we hear 9DED, Ralph R. Williams, Denver, Colorado, calling NPO. In that short space we have heard three amateurs on the Pacific coast, we have heard the U. S. S. *Utah*, a cool 2500 miles away, and we have heard Honolulu approximately 5000 miles distant. Not bad for one hour! It has been broad daylight all the time—traditionally bad for radio work.

AUSTRALIA—IN ONE JUMP!

FRIDAY, July 10, we come to the station early again, and at 6:30 A. M. we send a message to our home via 8GZ, Loren G. Windom, Columbus, Ohio. We also have a message for Australia, but do not have the nerve to transmit it to this amateur in Ohio, only 800

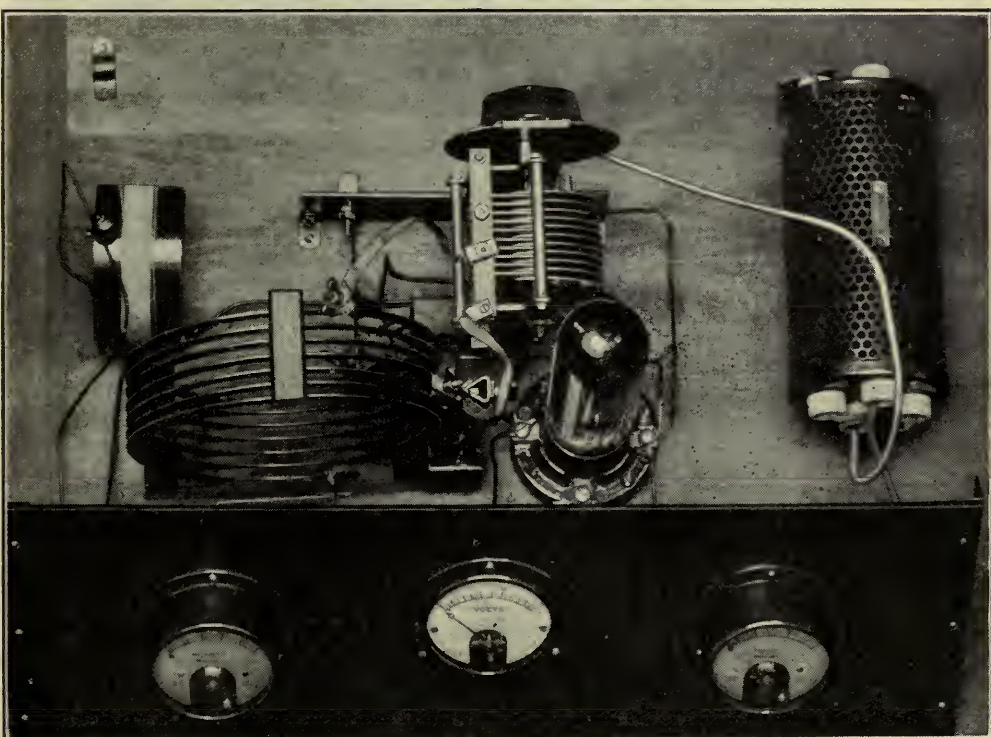


FIG. 2
A close-up of the 50-watt transmitter and the 40-meter inductance. The small coil on the left is a choke coil to keep radio frequency voltages out of the plate supply, and the mouse trap arrangement on the right is an external shunt for the kilovolt meter. A double-spaced Cardwell condenser is used for tuning

miles away. A half hour later we hear Australian 2CM working 8GZ. What hard luck! Had we given the message to the Columbus operator, it would have been in Australia in one half hour, better than any cable could do. It is 9 P. M. in Australia, 5 o'clock Central Standard Time in Ohio, and 7 o'clock Eastern Daylight Saving time in Garden City.

Honolulu is on again this morning as well as 4RL, Mario Castro Fernandez, Santurce, Porto Rico.

The next time we listen is on July 29 at 9:20 P. M. We hear 1CKP, George H. Pinney, South Manchester, Connecticut, calling WNP. There are thousands of amateurs on the frequency band of about 7500 kilocycles (40 meters), all pounding away, working, or trying to work, with each other. In this bedlam of signals it is difficult to pick out any particular one. We call several, but not until 10:30 do we raise any one. It is 1BQU, Alden C. Eldridge, Buzzards Bay, Massachusetts, and we converse for a half hour. At 11:52 we connect with 8AMS, Albert H. Buch, Tawas City, Michigan. This is better and we have hopes of reaching out. Nearly an hour later we communicate with 9MN, Robert C. Berry, Louisville, Kentucky, and then with 9EK, our friends at the Burgess Laboratories, Madison, Wisconsin. We feel pretty good over this communication, for we have been trying for a week to get together. We give him a message from Mr. Doubleday.

It is now 2:00 o'clock and our ears hurt from wearing the phones so long so we take a brief rest. A half hour later we listen in again and note that many stations have dropped out of the hunt for "dx." It is possible that we shall work the coast. Our signals are answered by 9NN soon. He is Chas. R. Jarosewicz at Chicago and a few minutes later we connect with 9AMM, James Gwynn, Shenandoah, Iowa. This is "out west" from Garden City and our hopes rise again.

Seven minutes elapse before we touch the key again and then we send out a general call, "CQ." Who should come back but 6TX, R. M. Thacker, Baldwin Park, California! We have worked the coast. In twenty minutes, 3:24 A. M. to be exact, we click with another Californian, 6JP, Oscar Roediger, San Francisco. He says "FB," which in amateur language means "fine business."

At 4:25 we get a long message from 4ASK, Florida, which we try to phone to the Waldorf Astoria Hotel. The telephone operator there says she is not in the habit of getting telegrams phoned to her, especially telegrams that relate to Florida real estate and a young lady who wants to marry somebody now at the Waldorf. If it were not illegal we would pass this whole message on, for it is a good one, but that is impossible, since it would violate the oath of secrecy assumed by every licensed operator.

It is now 5 o'clock and we are hungry, sleepy, and happy. We have worked two stations in California and many at less distance.

THE RESTRICTED BRITISH AMATEUR

THIS night's work was so successful that we try it again, the next evening, July 30. At 10:00 we get in touch with 9BBJ, James R. Freyermuth, South Bend, Indiana, with whom we have talked before. At 10:20 we work with 8DOO, Robert L. Miller, Royal Oak, Michigan. We now sweep all the amateur wavelengths for WNP, for we have messages for MacMillan. We do not hear a sign of him, but hear British 2SZ calling WNP. In a half hour this Britisher is working WNP and telling him that British regulations would not permit him to take messages. Stupid regulations, we think.

It is not a good night and it is after 1 o'clock before we connect with 8CCM, Eugene Rupprecht, Grand Rapids, Michigan. Not much later we click with 9CCA, Kurt T. Johnson, Chicago, Illinois, and finally work 6CPF, Bryson Walker, Hollywood, California. There are many Californians on the air and also 7IT, A. C. Dixon, Jr., Stevensville, Montana. Finally 9EFS, Lee Jensen, Marshalltown, Iowa, tells us that a bad thunder storm is raging out his way which explains why so few Western stations answer calls from 2GY. NVE, the *Utah*, is on again and working a number of Eastern stations. The Zenith station, 9XN, at Chicago, is working with WAP, S. S. *Peary*, the second MacMillan vessel now in the Arctic.

The next night, July 31, we have fair success with the transmitter, working down into several Southern states. The receiver, however, is doing remarkably well, for we log New Zealand, 2KF, British 2NM, Chilean 1EG, Australian 3BD, and Mexican 1AA, and 1B. All of this is around 40 meters—and is only an extremely small part of the frequency spectrum above 1490 kilocycles (below 200 meters).

The station operated by the RADIO BROADCAST Laboratory came on the air for the first time June 18, 1925, and by August 10th had worked amateurs in twenty states and two provinces of Canada. Many of these stations were worked in the daytime, feats of transmission and reception that would be impossible on the lower frequencies (longer waves). The power required to carry on these communica-

tions has never exceeded 130 watts, and together with that required to heat the filament of the "50 watter", totals less than 200 watts. The average electric iron requires 400 watts of energy. The cost of the apparatus has been about $200, a sum required for a good receiver with its accessories. At the time this is written, in August, very successful communication is being maintained over 800 miles with a power totaling less than 40 watts, and some very good results have been secured with ordinary 5-volt receiving tubes used for transmitting purposes.

THE B. C. L. IS MISSING SOME GREAT RADIO SPORT

IMAGINE sitting in your home with apparatus as inexpensive as that of 2GY and conversing with fellow amateurs in England, or Australia, or South America! Is it any wonder that the 17,000 licensed amateurs in this country think that broadcast listeners have something yet to learn before they have tapped the greatest source of radio interest?

The transmitting tube is somewhat different from those with which broadcast listeners are familiar. Its filament requires 10 volts and burns up 6 amperes! Its plate battery requires 25 of the ordinary 45 volt B batteries, 1100 volts in all. The average plate current is 100 milliamperes, or about that required by five average broadcast receivers. Another source of high voltage that has been used successfully is an "S" tube rectifier also shown in the photograph below.

The antenna system has suffered many vicissitudes. It has consisted of nearly everything from a brass gas pipe to a fan of wires stretched between the two 85-foot masts. At the present time it consists of a single vertical wire one-half wavelength (65 feet) long. It is "fed" from the transmitter, which is actually some distance away, by a single wire, and although one half ampere of current flows in the center of the antenna, there is very little energy in the "driver" wire itself. It is a curious arrangement, but it works.

At the time this is written, plans are being

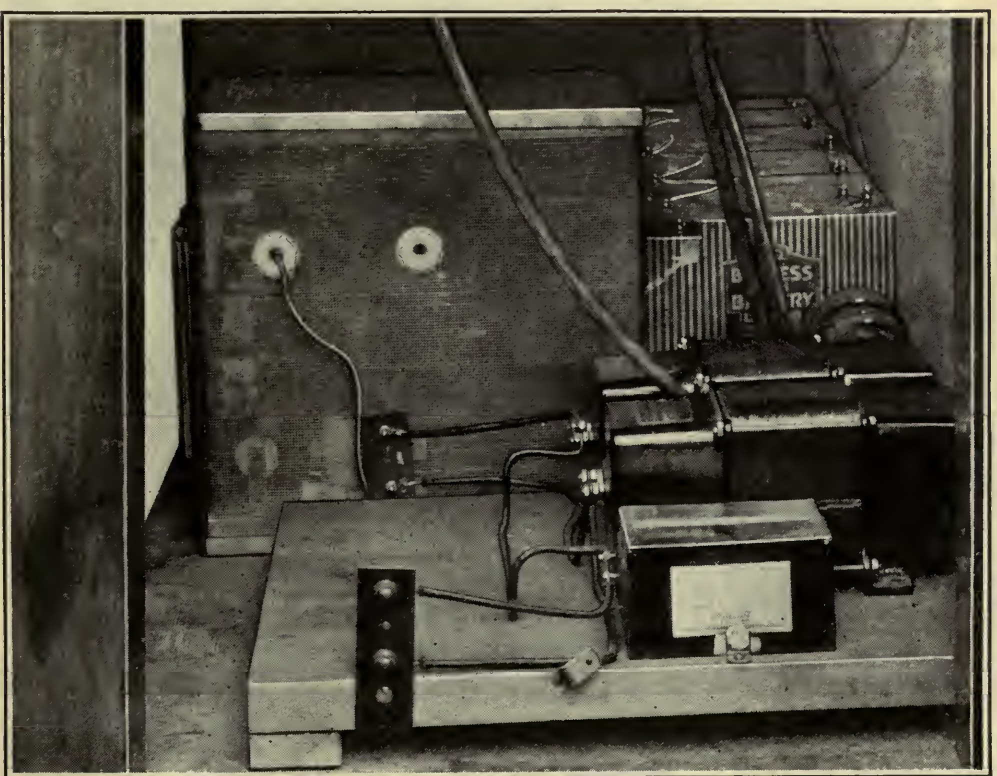


FIG. 3

An S tube rectifier and filter. The S tubes are in the cage together with an Acme 1500-volt transformer and control resistances. The filament transformer, behind the R. C. A. filter coils, is a home-made affair. The filter condensers are high voltage paper condensers

formulated for a complete investigation of the phenomena underlying transmission in this very high frequency (short wavelength), region. It is an adventure into unknown fields. There are many amateurs on their narrow bands down there, and a few commercial and naval stations are carrying on long distance communications down there also. Marconi is experimenting with "beam" transmitters, and there are a few broadcasters like KDKA and WGY who have high frequency (short wave) channels. There are many harmonics from broadcast stations down there too—but there are thousands of wavelengths and only a few to use them at present.

This experimental work will be carried out jointly by the Laboratory of RADIO BROADCAST and the National Carbon Company and will include the building of accurate frequency meters, short wave transmitters and receivers, especially low-powered, battery-operated affairs. The interesting things that occur down in this strange territory are too many for the broadcast listener to pass up entirely, and from time to time the Laboratory will conduct a small pictorial and verbal tour for our readers.

For the benefit of amateur readers it may be said that 2GY has an operator on duty all day and night. The station will be glad to communicate with any amateur on any wavelength at any time, to relay, or deliver messages or to carry out tests that may be mutually interesting. The station will be glad to check amateurs on their transmitting frequency (wavelength), and it is possible that a calibrating service will later be organized so that wavemeters or receivers may be accurately calibrated for amateurs who desire the service.

Reports of the reception of signals from 2GY will be greatly appreciated. They should be sent to the Director of the Laboratory, RADIO BROADCAST, Garden City, New York.

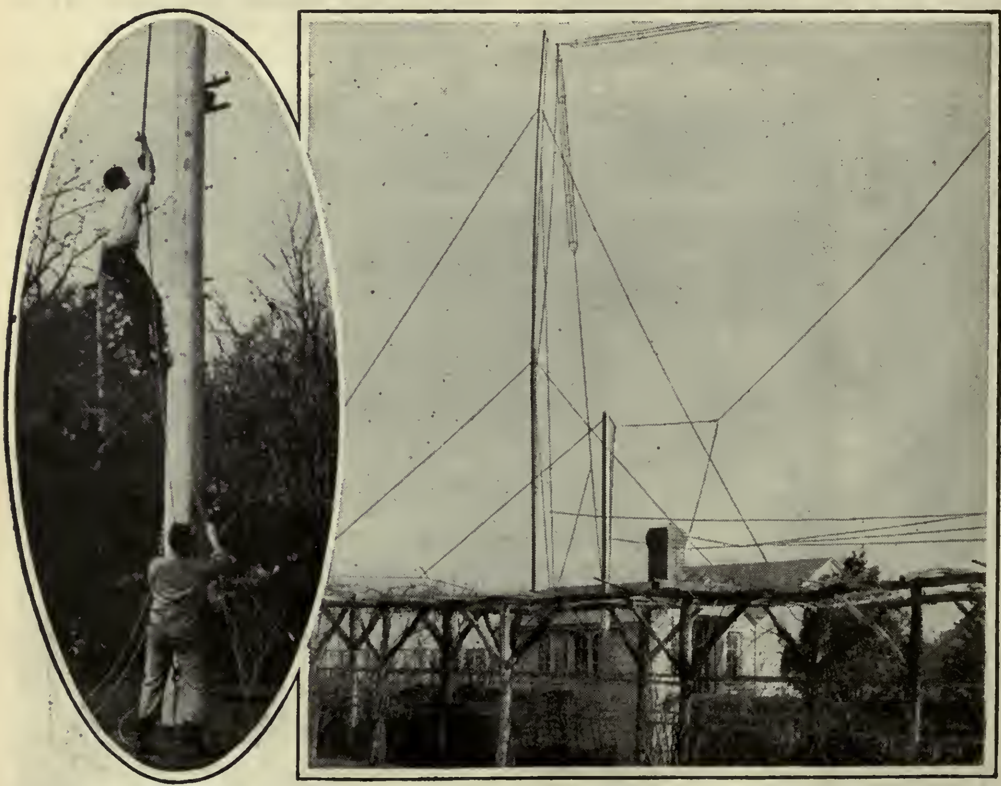


FIG. 4

The "shack" which houses 2GY. This was built originally for the International tests, but is now used for short wave transmission and reception entirely. In the spring the arbor is covered with roses and wisteria—but they have little to do with short waves. The insert shows some of the effort which has been expended on the masts and gives an idea of their size. The cage has been replaced by a single wire receiving antenna and a variety of transmitting antennas are used, strung from a rope between the two 85-foot masts 150 feet apart. A single wire 40 meters long, hung vertically downward, seems to be as efficient a radiator as any other

For the Radio Beginner

How to Build a Simple One-stage Amplifier

THE "Radio Beginner" this month guides the newcomer through the construction of a simple one-stage audio frequency amplifier. The addition of this amplifier will add no little bit to the possibilities of the crystal and single-tube receiver, while its construction will contribute a valuable fund of practical knowledge to the experience of the builder.

In the elementary theoretical section of this department, Zeh Bouck, its editor, discusses the fundamental action of the vacuum tube in preparation for future articles on its action as a detector and amplifier. References for outside reading, treating on the material covered in "The Radio Beginner" this month, are suggested to the student reader.—THE EDITOR

THE output of any of the receivers we have so far described in the past numbers of this magazine (for July, August, and September) can be amplified, or made louder, by the addition of a simple audio-frequency amplifier. The conventional amplifier consists of some means of coupling the output of the radio receiver proper (a transformer in this case) to an extra tube, where it is amplified by means of the well-known relay characteristics of the tube.

The following illustrations and text show how such an amplifier can be built up on a baseboard. The task is well within the experience and ability of the beginner.

LIST OF PARTS

THE electrical parts necessary for the construction of the amplifier are photographed in Fig. 1 and are as follows:

IN FIG. 1	DESCRIPTION	APPROXIMATE PRICE
No. 1	Standard socket	$ .25
No. 2	10-ohm rheostat (base mounting type)	.25
No. 3	6 binding-posts at 5 cents each	.30
No. 4	Audio-frequency amplifying transformer	4.00
	Total	4.80

The parts designated are designed for use with a standard five-volt tube. If it is desired to use a three-volt tube, which is quite satisfactory in a single stage of audio amplification, a thirty-ohm rheostat and a socket for the small-based three-volt tubes should be substituted for the parts listed.

RADIO BROADCAST Photograph

FIG. 1
The electrical parts used in the construction of the simple amplifier

Any reliable make of amplifying transformer will give satisfaction. A Jefferson transformer was employed in the amplifier photographed and described. When purchasing the parts specify a three-to-one ratio transformer. This means that the secondary winding will have three times as many turns of wire as the primary, a ratio the writer recommends for all around amplification. A higher ratio, however (up to six to one), will work satisfactorily in the first stage of amplification.

The parts are mounted on a wood base five and one half inches long by five inches wide, according to the layout suggested in Fig. 2. The radio beginner will find it worth while to sandpaper the base, bevel the upper edges slightly, and to stain it a dark green.

WIRING IS THE NEXT PROCEDURE

FIGURE 3 shows the wiring diagram in two forms. Diagram A is the standard schematic arrangement employing the usual electrical and radio symbols. Diagram B is a pictorial layout of the same hookup which may be of greater significance to the beginner. Comparison of these two sketches will explain Fig. 3A. The reader should familiarize himself with this system of circuit diagramming.

Examination of the transformer will show four binding posts or connecting terminals. These are generally grouped into two on each side, one group marked P (indicating the primary winding), and the other S (designating the secondary winding). One post in group P is marked "P," which indicates that this terminal should be led through to the plate of the preceding tube. The remaining primary binding-post will be marked either with a plus sign, or "B" or "B Bat," meaning that this post should connect with the positive terminal of the B battery. The secondary posts will be marked "G" and "F" or "G" and a minus sign, signifying respective connections to the grid of the amplifying tube and the minus side of the filament lighting or A battery.

There will be four posts on the socket marked "P" for plate, "G" for grid, and two marked "F" for filament. Occasionally plus and minus signs are substituted to indicate the filament binding-posts. The rheostat will have two binding-posts, unmarked.

Binding-posts 1, 2, 3, 4, 5 and 6 (Fig. 3) are wired respectively, by the shortest possible routes, to the "P" transformer connection; the "B Bat" transformer terminal; one filament post on the tube (plus if marked), to the rheostat and "F" terminal on the transformer; and to the plate of the tube. Post 6 is left blank.

The remaining post on the rheostat is wired to the second filament terminal on the socket. The "G" post on the transformer is wired to the similarly marked socket post, completing the wiring of the amplifier.

Bare No. 18 copper wire, covered by black spaghetti, lends a neat appearance to the finished amplifier, shown in Fig. 4.

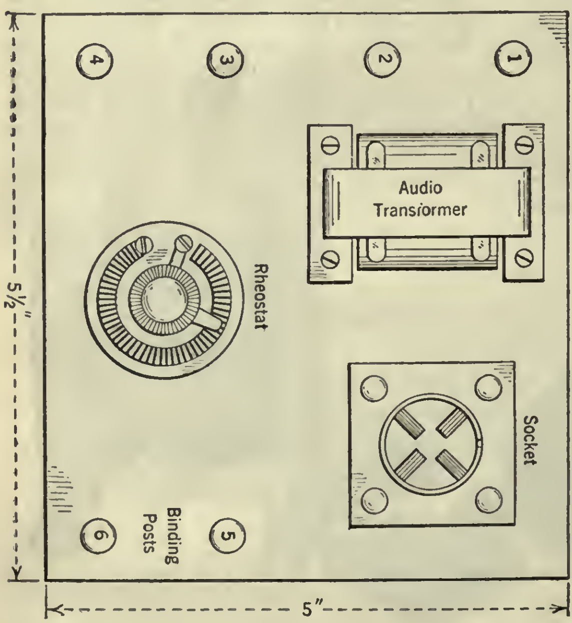


FIG. 2

Dimensions of the baseboard, indicating the positions of the various parts

HOW THE AMPLIFIER IS CONNECTED

THE amplifier we have described is designed for operation immediately after a crystal or bulb detector, or following the single tube on the RADIO BROADCAST One-Tube Reflex receiver and similar sets. It should not be used as the last step in a multi-stage amplifier.

The principle of connecting the amplifier is the substitution of the input posts, 1 and 2, for the telephone receivers in the original circuit by phone plug or binding-posts. The telephone receivers, or loud speaker, are then connected at the output posts, 5 and 6.

Fig. 5 shows how the amplifier is

connected to a crystal receiver, such as that described in "The Radio Beginner" for July.

A suitable A battery for the tube used—six volts for a standard five-volt tube or 4.5 volts for a three-volt tube—is connected with the positive terminal to post 3 and negative to post 4. The minus side of a 90-volt B battery (built up of two 45-volt blocks or four 22.5-volt blocks connected in series) is connected to the plus terminal of the A battery. The positive side of the B battery is led to post 6, thus completing all connections to the amplifier.

The connections to a single-tube receiver are fundamentally the same. The A battery that lights the detector tube can also be used to light the amplifying tube. In order to simplify this, the same type of tube should be used both in detector and amplifier. The battery connections to the amplifier, when inputted from a bulb set, are shown as heavy lines in Fig. 6. If a tube detector is employed, it is probable that only 22.5 volts will be used on the plate of that tube. A larger battery is therefore added to the detector B battery, to supply plate current to the amplifier *only*. If the one-tube reflex tuner is used, the plate battery will probably already have a voltage of 90, and the extra battery will not be required.

In both crystal and bulb receiving sets, the amplifier will function best when the primary of the transformer is connected in a certain electrical direction (when P is connected to the plate of the preceding tube in the case of a bulb set), and the connections to posts 1 and 2 should be reversed experimentally.

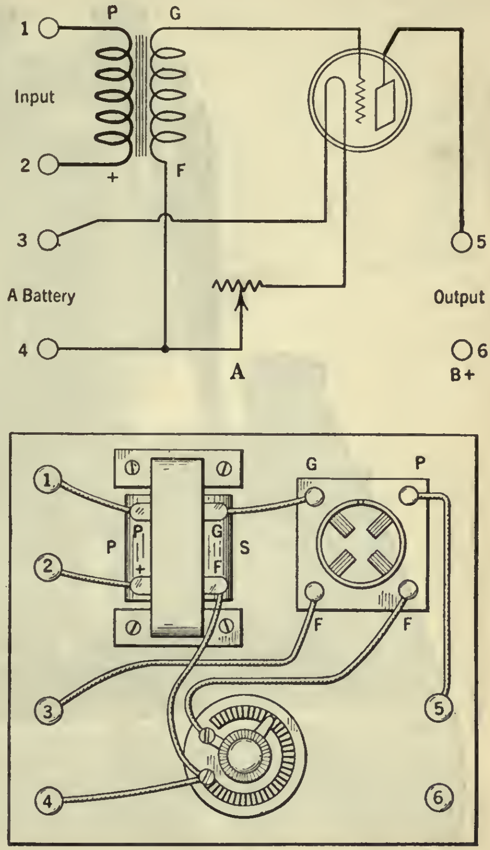
If any reader of "The Radio Beginner" is in doubt as to how his amplifier should be connected, the technical editor will be pleased to indicate the connections, if a diagram of the tuner is submitted to him.

OPERATION

THERE is no tuning or other adjustment on the amplifier. The filament should be turned up to the proper brilliancy, as evidenced by satisfactory operation, after which the amplifier functions without attention.

Used with a bulb detector set, the one-stage amplifier will give fair loud speaker signals. In conjunction with the one-tube reflex, the signal strength will be sufficient for dancing in a small room. Inputted from a straight crystal detector, volume will seldom be sufficient for loud speaker operation, but will give comfortable ear phone reception on signals that are very weak unamplified.

The intensity with which distant stations can be heard, is increased slightly by the addition of the Radio Broadcast Beginner's Amplifier.



B

FIG. 3

How to wire the amplifier. Diagrams A and B are identical. The reader should endeavor to familiarize himself with the schematic system (A) of circuit diagramming

THE RADIO PRIMER

Fundamental Ideas behind the Vacuum Tube

AS WE analyze matter—going down through the molecule, atom, and ion—we arrive at what appears to be "the thing itself," the fundamental component of all matter further than which science of to-day has been unable to guess or travel. All matter, from bricks to sewing machines, is apparently built of these tiny philosophical bricks known as electrons, which, so evidence

FIG. 4
The completed amplifier. Black spaghetti-covered wiring adds a neat professional touch

RADIO BROADCAST Photograph

tells us, are infinitely small charges of negative electricity.

We have reason to believe that whenever electrons move in a coöperative motion away from the atoms with which they have been associated, their movement is evidenced as a current of electricity. A haphazard motion, or a regular movement within the atom does not give rise to this phenomenon; for electrons are continuously moving about in this manner—in the paper on which I write, in the magazine which you are reading, and in millions of other things that at this moment exhibit no electrical characteristics. This perpetual activity of electrons within the atom is stimulated by temperature. The higher the tem-

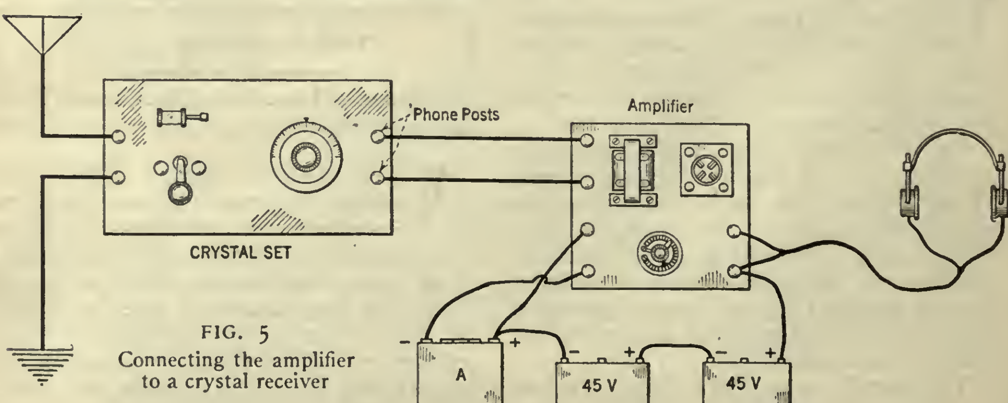


FIG. 5
Connecting the amplifier to a crystal receiver

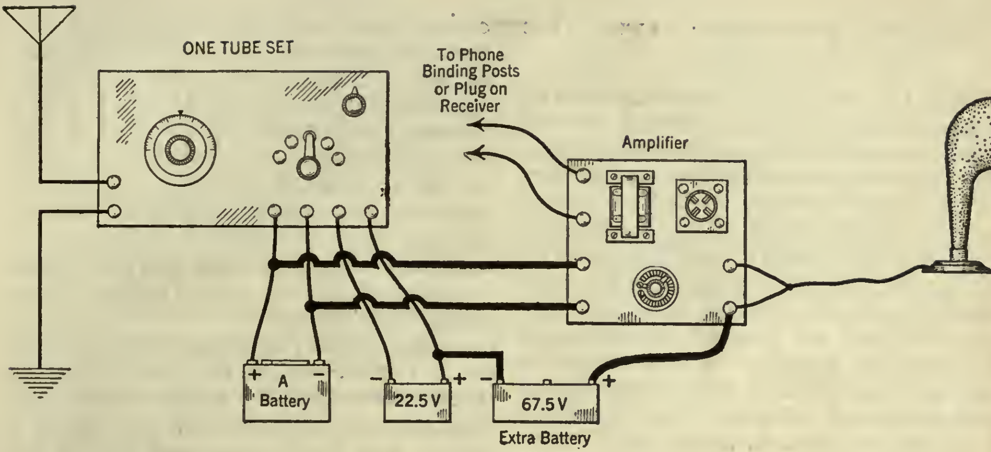


FIG. 6
The amplifier connected to a bulb set. The heavy wires indicate the battery connections to the amplifier

perature, the faster these unimaginably tiny negative charges move. If the temperature is made sufficiently high, the electrons will move so rapidly that many of them will fly away from the atom—like mud from a rapidly revolving wheel.

For instance, the sun, hotter than anything of which we know on this earth, is throwing off electrons in vast trillions. Many millions pass the earth each second. Above ground they "occasionally" (countless times per second) hit atoms of air. The collisions are visible as light; we see it thousands of miles away. We call it the aurora borealis. The reason the air below is not ionized (which is the scientific term for this generation of light) is that the atoms of dense atmosphere down where we breathe are too close together and would merely stop the motion of the electrons, instantly lowering their velocity below the high speed required for ionization.

If we heat a wire sufficiently by holding it over a candle flame, it will give off electrons. If a plate, or sheet of metal, is placed close to the heated wire, and a powerful electrical positive charge is applied to it as shown in Fig. 7, the electrons will be attracted over to the plate (remember that unlike charges attract each other). In other words, an electric current will flow through the circuit. The current will be a very small one due to the obstructing effect of the atoms of air. However, if the plate and hot wire are sealed up in a vacuum, the electrons will have a free path to the plate and comparatively high currents can be passed. This is done in the vacuum tube whose constructional principles are sketched in Fig. 8.

It is impossible now to heat the wire with a candle flame, so it is made hot by passing through it a current of electricity, just as a similar current heats the filament of the electric bulb in your reading lamp. This current is supplied by the filament or A battery. The positive charge is applied to the plate or "anode" (positive electrode), by the B battery.

When the filament is heated, generally to fair brilliance, electrons will be freed to fly to the plate through the vacuum and a current will pass through the tube.

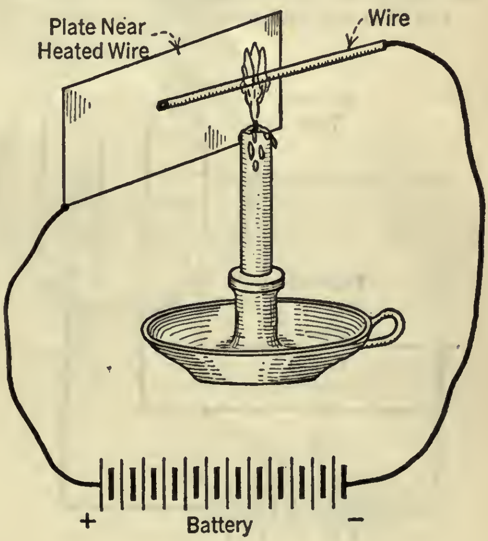


FIG. 7
The principle of the filament in a vacuum tube. The filament battery is applied to heat the filament to a high temperature

"UNILATERAL CONDUCTIVITY": WHAT THE TERM MEANS

IT WILL be observed, in the arrangement we have sketched and described, that electrons will flow only from filament to plate, because there is no reversal of conditions to make them go backward. In other words, the vacuum tube can pass electricity in *only one direction.* Thus, if an alternating e. m. f. (electromotive force) were applied to the plate of the tube, current would flow through the circuit only when the plate was positively charged—that is, one half of the time. In this respect the bulb is similar to the crystal detector that we discussed in this department for August, and it can be substituted for the crystal.

It is readily understood that this rectifying action is comparable to a valve, which shuts off the current on one half of the cycle and passes it on the other. This type of tube—a two-element (filament and plate) bulb—has been named the "Fleming Valve" after Dr. J. A. Fleming, the English scientist who first applied it to the detection of signals. Modifications of the Fleming Valve have several uses to-day, the most common among which is the "Tungar" bulb used to rectify alternating current in battery chargers.

Mr. Lee De Forest gave us the vacuum tube used in modern radio when he inserted a third element, the grid, which is a wire screen looking something like its diagram symbol shown in Fig. 9, between the filament and plate.

But it is another matter when an electrical charge is placed upon this grid. If a negative charge is applied to this third element, it will repel the electrons (it is an old electrical axiom that like charges repel each other) and none can pass through to the plate. Thus the current through the tube—or "plate current" as it is called—will be decreased or stopped. On the other hand, if a positive charge is imposed on the grid, more electrons would be drawn from the filament, and by the time they travel as far as the grid, most of them are attracted by the greater positive potential on the plate and will pass through to it. The result is an increased plate current in the circuit plate to B battery to filament. The sketches in Fig. 10 serve to illustrate this interesting action.

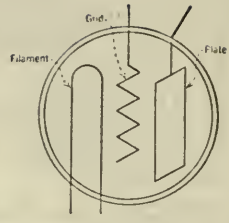


FIG. 9
How the usual three-element tube is indicated

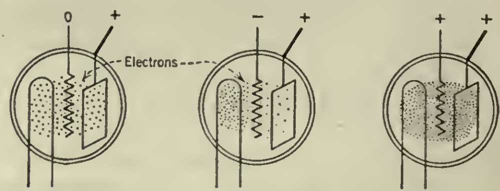


FIG. 10

In A, the grid is at zero potential and an average number of electrons flow to the plate. As the grid is given a negative bias, in B, the flow of electrons (which causes the current in the plate circuit) decreases, to change to a comparatively large current with the plus charge in C.

The commercial tubes with which you are familiar have these three elements—and function in the manner we have described.

They can be obtained in various types having minor differences in electrical characteristics such as filament potential and current, but the fundamental action—the control of the plate current by the grid charge—remains the same. This control action is often referred to as a "trigger" or relay action, for like the trigger in a pistol or a relay in any electrical circuit, a variation in the charge on the grid can be made to control or set loose much greater power in the form of plate current variations. It is also a relay action in

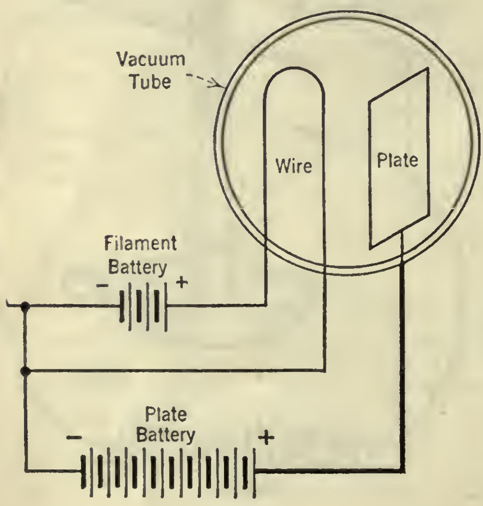


FIG. 8
The two-element vacuum tube, sometimes called the "Fleming valve" after its inventor, Dr. J. A. Fleming

the sense that the current in one circuit can be shut off by the impulses in another and totally different circuit. For instance, in Fig. 11, in which A is a magnetic relay circuit and B is a vacuum tube circuit, the closing of key K, in either system, will break the circuit through the telephone receivers. In A, the lever will be pulled down, opening the circuit at S, and in B, the high negative charge supplied to the grid will open the circuit at S.

THE RADIO LIBRARY

THE fundamental action of the vacuum tube is explained in almost every modern radio book. The student reader will find the following bibliography of interest and assistance:

The Outline of Radio, by John V. L. Hogan, Chapter eight. An easily understood exposition of detection.

The I. C. S. Radio Handbook, pages 216 to 237. This is less elementary but should be easily followed by the reader who comprehends most of what he has so far read in "The Radio Beginner."

Vacuum Tubes in Wireless Communication, by Elmer E. Bucher. Parts One and Two. Less elementary.

Principles of Radio Communication, by J. H. Morecroft. Pages 364 to page 467. This particular book is recommended to the engineering student. While starting with the simple elements of the vacuum tube, it rapidly develops into a mathematical exposition of the subject.

Vacuum Tubes, by H. J. Van der Bijl. A similarly exact but perhaps more thorough research than the excellent chapters by Professor Morecroft.

THE RADIO LEXICON

IONIZATION: A phenomenon caused by the passage of current through gases—generally rarified. Mechanically, it is the result of repeated collisions between the infinitely small particles of which we believe matter to be composed. It is usually evidenced by a visible glow or haze.

FILAMENT: The wire in a vacuum tube which is heated, generally to incandescence, and which in this condition throws off electrons.

PLATE: The metal "anode" or element in a vacuum tube upon which a positive charge is placed to attract the electrons from the filament.

TUNGAR BULB, RECTIFYING TUBE, FLEMING VALVE: Trade and technical names for a two-element, plate and filament, vacuum tube.

GRID: The third "element" introduced between the filament and plate by Mr. Lee De Forest. It controls the flow of electrons from filament to plate by means of the electrical charge placed upon it.

PLATE CURRENT: The current through a vacuum tube which flows from filament to plate.

SPACE CURRENT: Generally the same as plate current, but occasionally used in reference to a current between grid and filament or plate.

A BATTERY: The cell or battery supplying the filament lighting potential to a vacuum tube.

B BATTERY: The battery applying the high positive potential to the plate of a vacuum tube. (Usually of from 22.5 to 135 volts).

RHEOSTAT: A variable resistance of comparatively low maximum ohmage. In radio, it is generally used to regulate the voltage applied to the filament.

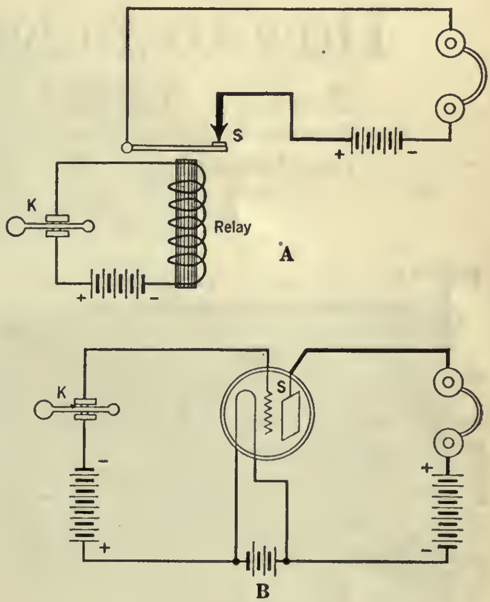


FIG. 11

RADIO BROADCAST Photograph

FIG. 1

Tubes of many manufacturers. The round one in the foreground is a Western Electric 216-A, particularly adapted for use in the last audio amplifier. Two "high-mu" tubes are shown, one from the Cleartron Tube Company and the other sold by the Daven Radio Corporation. The others are standard 3- and 5-volt tubes

How to Judge Radio Tubes

Signposts to Tell What Factors Make a Good Tube—Results of Laboratory Tests on Many New Tubes—Two New Batteryless Receivers—A New Current Supply Device

BY THE LABORATORY STAFF

THE tube and its batteries are the only things that should wear out in a modern radio receiver, and the economics of the tube is an important consideration when the broadcast listener is on purchasing bent.

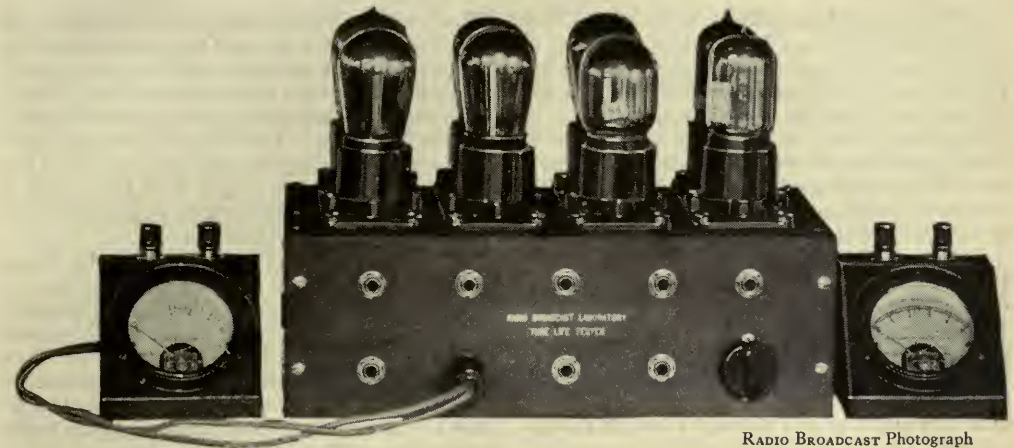
In the usual five-tube set the vacuum tube performs the functions of radio frequency amplifier, detector, and audio frequency amplifier. In some receivers, such as the super-heterodynes or the regeneratives, the additional task of oscillation is placed on the tube, and in reflex sets, some of the tubes do two tasks at the same time. It is no wonder, then, that broadcast listeners should be careful of the tubes that they buy.

Within the last few months, the RADIO BROADCAST Laboratory has received samples of receiving tubes manufactured by many of the 100 manufacturers now in this business. Some of these tubes have been worthless, some very good. The data printed this month represents 71 tubes from 11 manufacturers and are the best of the many that have been tested. The average of these figures is an interesting and useful standard by which tubes may be compared. One assumes that in both manufacturing and purchasing a tube, the most important question which arises is "what is a good tube?"

The answer involves two factors, the electrical characteristics of the tube and the factor of economics. How long will the tube last?

Electrically speaking, there are three factors which completely define any particular tube: the amplification constant, the plate impedance, and the mutual conductance. These terms may not mean as much to the radio buyer as "stroke," "bore," "wheel base" and other similar ones do to the automobile purchaser, but they are tremendously important to the shopper for tubes.

All three indicators are bound up in the mechanical construction and placing of the elements, and the efficiency of the filament. The construction and location of the elements are really a manufacturing detail; the efficiency of the filament is, then, the vital factor upon which the value of the tube depends. Unfortunately, the production of filament wire, especially modern oxide coated or thoriated wire, is not a simple task. It is said that much of



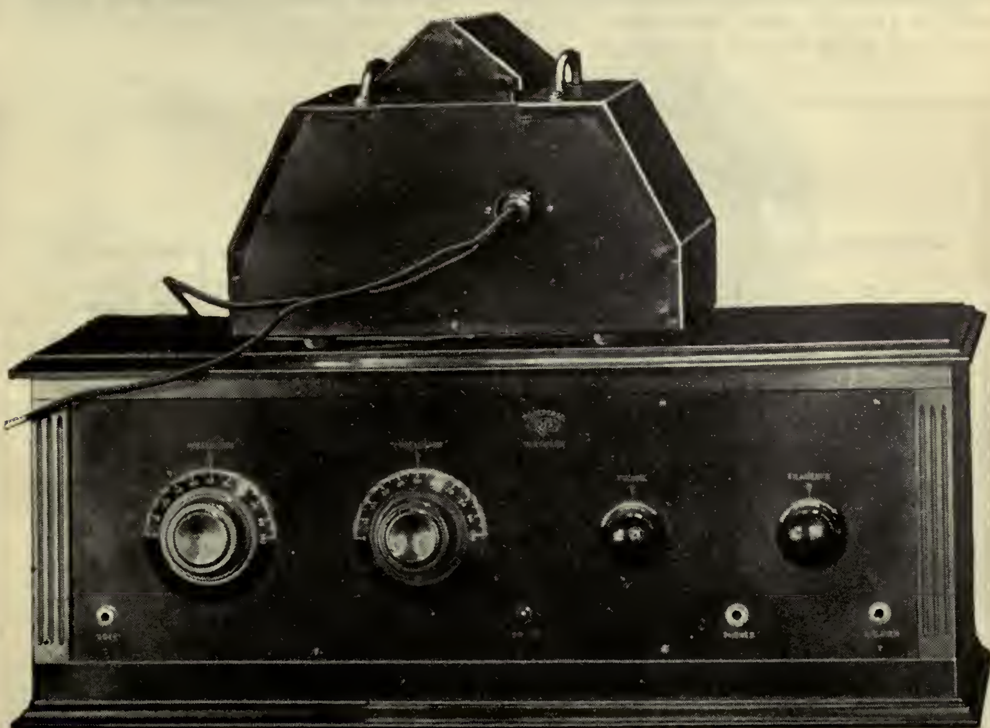
RADIO BROADCAST Photograph

FIG. 2

Tube life tester used in the Laboratory. Meters are provided for maintaining the filament voltage at proper value and for reading the plate current at regular intervals

the wire in present tubes is said to be stolen from the large manufacturers who own the patents and processes for making the wire. Some of the wire in tubes not made by those who control the manuacture of this filament wire is imported, some of it is made for independent concerns by men who have been enticed away from the larger laboratories. One spool of wire will make hundreds of tubes.

The amplification factor of a tube is a measure of the voltage amplifying ability of the tube and should, in an amplifier, be high; the plate impedance is the electrical impedance which it places in the circuit



RADIO BROADCAST Photograph

FIG. 3

The Radio Receptor Company's batteryless receiver. This receiver will operate from a loop. The rectifier tubes are in the compartment on top of the receiver

in which it is used, and should be low; the mutual conductance relates to the importance of the grid in controlling plate current. It is also the ratio between the amplification factor and the plate impedance, and should be as high as possible.

In general there is no object in a tube of high "mu" (amplification constant), if the plate impedance increases correspondingly, although for resistance and impedance amplifiers there is much to be said for tubes with high voltage amplification.

For audio amplifiers, it is highly important that tubes of low impedance be used from the standpoint of quality and power amplification while in radio frequency circuits, tubes of low impedance will give greater gain and more stable operation. The future trend of tube development seems to be toward lower impedance tubes that may be used as power amplifiers with plenty of grid bias and a high B battery voltage. The new Radiotrons will do much to fill in the gap between the ordinary 5-volt tube and the 5-watt power tubes. Several independent tube manufacturers have realized the need for semi-power tubes and it is probable that the early winter will see high power, high quality amplifiers in more general use than has been possible up to this time.

GOOD FILAMENT WIRE MEANS GOOD TUBES

THE heart of the tube is the filament, and those manufacturers whose filament wire is good can make good tubes. Otherwise they can make only mediocre products whose characteristics will be erratic and whose life will be uncertain. Many tubes have excellent characteristics when placed on test, but after a few hours of service the supply of electrons has been exhausted and the tube is dead.

For a given number of watts expended in heating the filament, the user should get a certain number of plate milliamperes. The filament efficiency, on the table shown as "mils per watt," is a measure of the value of the filament. Tubes with high filament efficiency will usually have a higher mutual conductance, as the table plainly shows.

It is probable that all of the tubes listed will give comparable results, and although measuring instruments will show that some give greater amplification than others, the ear will not be able to distinguish the difference. None of the poor tubes has been listed in this table. Since the customary practice is to run amplifiers at 90 volts on the plate and negative 4.5 volts on the grid, the data given was taken under those conditions.

In the Laboratory, these characteristics are measured and the tubes are then placed on a life test. They are run at normal filament voltage with the grid connected to the negative filament and with about 120 volts on the plate. At the end of 200 hours, if the tube is still "alive," the characteristics are again measured and another 200 hours test is run through. For this reason it takes considerable time before the Laboratory is certain of the qualities of any given tube.

Fig. 1 is a photograph of some of the tubes that have been tested and Fig 2 shows a tube life tester in use in the Laboratory.

RADIO BROADCAST LABORATORY
REPORT ON TEST OF
5-VOLT TUBES

TUBES	NO. TESTED	FIL. CURRENT	FIL. WATTS	PLATE CURRENT	MILS PER WATT	PLATE IMPED.	AMP. CNST.	MUTUAL COND.
Ceco	2	.25	1.25	5.6	4.5	14,800	7.2	508
Cleartron	8	.27	1.35	7.03	5.0	10,800	7.3	650
R. C. A.	10	.25	1.25	6.0	4.8	13,000	7.0	550
Diatron	5	.27	1.35	5.83	4.3	14,500	7.8	550
Jove	6	.27	1.35	6.7	4.95	10,000	5.6	603
Marathon	9	.25	1.25	8.45	6.75	9,600	7.0	700
Sea Gull	12	.23	1.15	6.7	5.83	10,000	6.6	660
Silvertone	5	.22	1.1	7.0	6.35	10,700	7.2	650
Van Horne	5	.23	1.15	5.8	5.05	13,600	8.33	615
Elektron	4	.25	1.25	4.6	3.68	17,400	8.45	483
Goode	5	.24	1.20	6.8	5.67	12,000	8.32	704
TOTAL	71	Avg. .244	1.22	6.0	4.93	12,400	7.7	606

CONDITIONS

FILAMENT VOLTS	PLATE VOLTS	GRID VOLTS
5	90	—4.5

Plate Current is at Zero grid

With each tube of the Van Horne Company of Franklin, Ohio, the purchaser gets complete data such as the characteristic curve, the plate impedance, amplification constant and mutual conductance. This gives the user an unusual check on each tube he buys.

BATTERYLESS RECEIVERS

IT HAS long been the dream of radio listeners to possess a receiver that required no batteries which would run from a lamp socket. Two receivers of this type have been tested recently in the Laboratory. One is known as the Multiflex and manufactured by the Radio Receptor Co., Inc., New York City, and the other is called the Powerola and is manufactured by the Terminal Electric Co., New York City. Neither of these receivers requires batteries of any kind, and both may be run from either direct or alternating current, both use standard tubes.

The development of receivers of this type has been interesting. It is a comparatively simple matter to secure proper plate potential from either direct or alternating current. The many B substitutes now on the market attest to this fact. It is not difficult to operate the filaments of amplifier tubes from alternating current either. The great obstacle in the way of a batteryless set, however, is the detector filament which must be fed from pure direct current.

Tungar tubes, such as are used for charging storage batteries, are one solution to this problem. If two of them are used to rectify both sides of the alternating current and if the output is sufficiently filtered, the detector and amplifier filaments may be run without A batteries. In receivers utilizing this means of filament supply, it has been customary to run the filaments in series to lower the current flowing. If 3-volt tubes requiring but 60 milliamperes filament current are used, it is possible to use as rectifiers two of the B battery substitute tubes. In this case the entire current requirements are about 70 milliamperes, which two rectifier tubes should be able to supply for considerable length of time without deterioration.

Both of these receivers, which were previously mentioned operated successfully in the Laboratory. The Radio Receptor set operated quite satisfactorily on a loop.

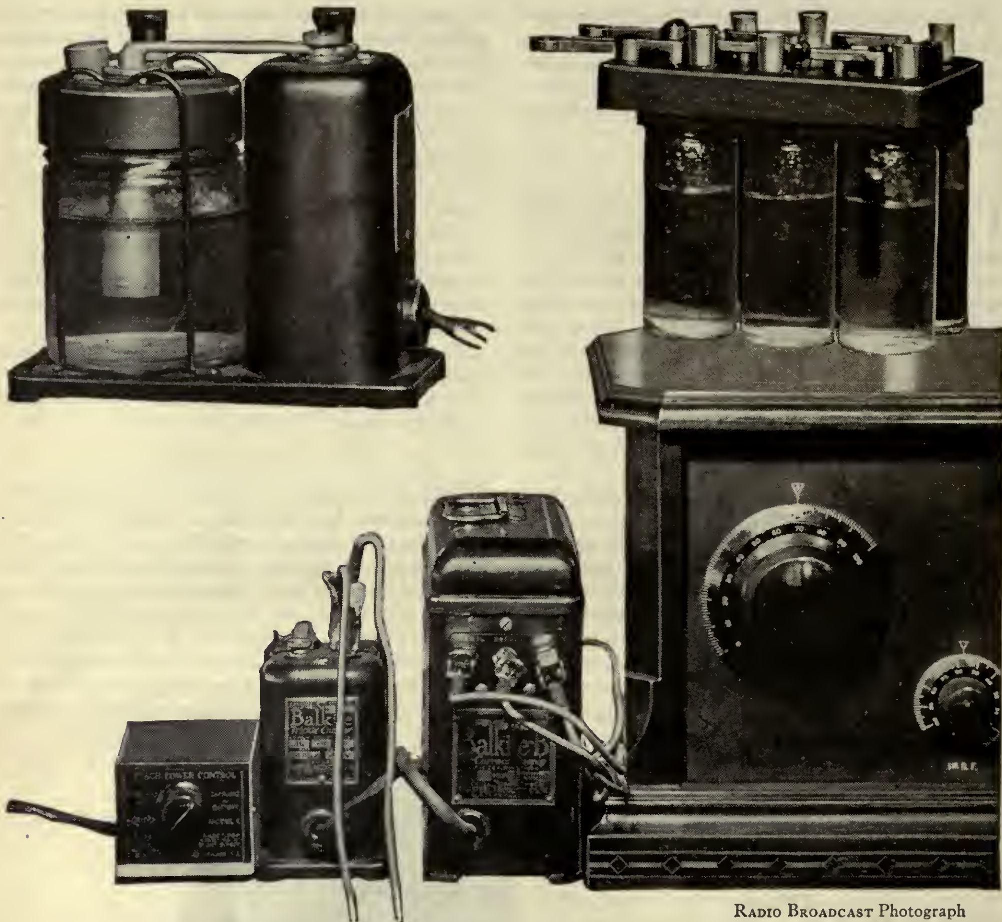
THE A. C. TUBE

THE A. C. Tube, which is attracting considerable attention, has several advantages. In the first place its filament—which is not really a filament at all—is heated by alternating current. This means that no A battery is required and that a person who has a.c. in his house needs only a small toy transformer to operate the filaments. No rheostat is required. This tube is the outcome of a great deal of work by many engineers on a "unipotential" cathode tube, which means little or noth-

FIG. 4

An excellent neutrodyne which, in the middle of the summer, picked up several Chicago stations and Miami Beach from Garden City. It is made by the Howard Radio Company, Chicago. With it is the Stewart Warner loud speaker, which is a very good horn, and an interesting power supply unit from Balkite

Radio Broadcast Photograph



Radio Broadcast Photograph

FIG. 5

A close up of the Balkite B-current supply and trickle charger. These units are very compact and are neat adjuncts to modern radio sets. The B current supply takes the place of B batteries and employs a chemical rectifier. The trickle charger may be left on the storage battery at all times when the set is not being used. In this way the battery is always operating at top efficiency. The Brach switch is a device to switch the A battery from "on-charge" to the receiver, with very little effort on the part of the user. The component parts of the B-current supply of the trickle charger and tantalum elements are clearly shown

ing to most of us, and is an important step in a proper direction. With such a filament heater, it should be possible to get very high filament emission with consequent high mutual conductance. This should be a great advantage, since mutual conductance is a direct indication of the value of a tube.

A. C. tubes tested in the Laboratory have worked sporadically. Sometimes excellent results have been secured, sometimes no results at all. The chief trouble has been noise from the a. c. hum. This can be ironed out, and a receiver brought to the Laboratory by the Pathé Radio and Phonograph Company worked beautifully with no batteries at all. The filament emission of the A. C. tubes may be somewhat higher than that obtainable from standard 5-volt tubes, but the mutual conductance of a number of these was about equal to that of the average 5-volt tube, although they were not so uniform.

At present it is difficult to say what the A. C. Tube will mean to radio. They have many possibilities, and may prove to be one of the most important contributions to modern reception. On the other hand, they will be useless to thousands of listeners who do not have a.c. At the present time it is believed that they have not reached the acme of development and the future must promise a great deal for this new tube.

"NOW, I HAVE FOUND . . . . ."

A Department Where Readers Can Exchange Ideas and Suggestions of Value to the Radio Constructor and Operator

A SIMPLE SOLUTION TO A COMMON PROBLEM IN ANTENNA CONSTRUCTION

RADIO fans who live in apartment houses or in densely populated areas are often confronted with almost insurmountable problems in the matter of erecting an antenna, and especially in the matter of bringing the lead-in down to a suitable window. A receiving set capable of operating on a loop is usually either too expensive or lacking in distance-getting qualities to be satisfactory in such locations, so an antenna is almost a necessity, undesirable though it may be.

The writer recently encountered and solved the problem of bringing a particularly difficult lead-in down the side of a large building.

The antenna was strung between two large electric signs over the center of the roof of the building and the lead-in brought down to an insulator on the end of a 2 x 2 inch piece of pine projecting a few feet (as far as was permitted) over the cornice of the building. It was secured with lag-screws. The wire was dropped down and brought in through a window frame. This is where the usual snag was struck. The trouble lay in the fact that the window was recessed in the usual manner, being about fourteen inches in from the face of the building. Directly over the top of the window was a tin channel bearing a series of electric lights running the length of the story. The wire, dropping vertically and then inward at a sharp angle, of course made contact with the channel and swayed back and forth between two of the sockets, at times also brushing across the upper portion of the structure.

To carry the wire out away from the building with a stick was not to be considered, because the window faced a busy thoroughfare only a few feet below, and the unsightly conglomeration of braces, guy wires, etc., necessary to such a method would not have been tolerated by the company for which the antenna was being erected.

The problem was at last solved in the following manner: A porcelain tube was run through a hole in the window frame of a size to make a very tight fit. Through the center of the porcelain tube was forced a three-foot piece of $\frac{5}{16}$ inch outside diameter brass tubing, so that the greater part of the latter protruded outside of the room into the open air. The hole in the brass tubing was large enough to allow the antenna wire to pass through. In this manner the lead-in was carried several feet out from the face of the building and entirely away from the electric light sockets, making a very neat and satisfactory job. The details are shown in Fig. 1.

H.A. HIGHSTONE,
Oakland, California.

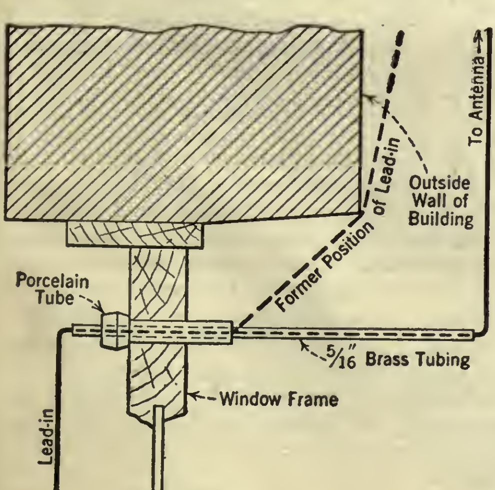


FIG. 1

A SELF-SUPPORTING "D" COIL

ALTHOUGH the toroidal coil is perhaps a trifle more efficient, the ease of construction together with its adaptabilities in the coupler and the variometer, make the D coil preferable in many cases, and the self-supporting feature adds to its efficiency.

A good wound-on-air coil of the D type may be constructed as follows: The nails or wooden pins which serve as a form on which to wind

the coil are inserted in a soft wood board in the same manner as that used for making low-loss solenoids, but are arranged as shown in the accompanying diagram, Fig. 2. The first turn is started by passing the wire inside pin 1 and outside pins 2 and 4 and then over 11, 9, 7, 5, 12, 14, 1, 3, 12, 10, 8, 6, 4, 13, 15. At this point, two turns have been completed and the third turn is wound over the first and the fourth turn will come directly over the second and so on.

It will be noticed from the diagram that pins 5 and 3 and pins 11 and 13 are relatively near to and equidistant from pins 4 and 12 respectively. That part of the circumference between pins 5 and 11 must be divided into some convenient number of equal parts of even number (6), and the portion of the circle between pins 3 and 13 is correspondingly divided into an odd number of divisions (5).

After the desired number of turns have been wound on, the coil is slipped up on the pins far enough to be tied at the intersections of the wire, with a strong linen thread. The pins are now removed and a very firm, efficient coil is the result.

Herman M. Patridge,
Newfields, New Hampshire.

A TUBE LIFE-SAVER

WHEN, after having built a new set, a test is made to determine whether the plate battery is accidentally connected with the filament circuit, one procedure is to try a regular tube in the different sockets,

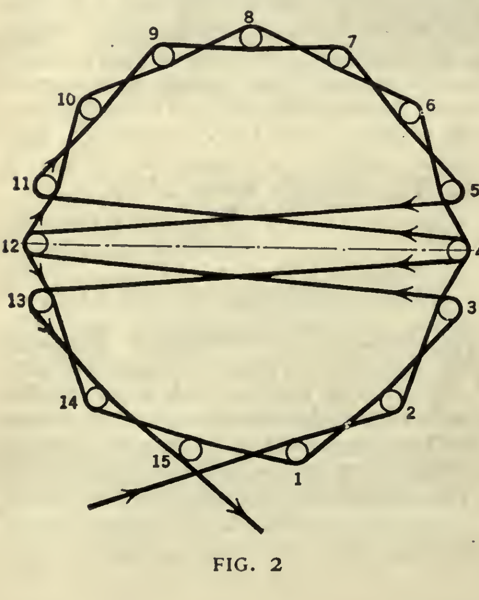


FIG. 2

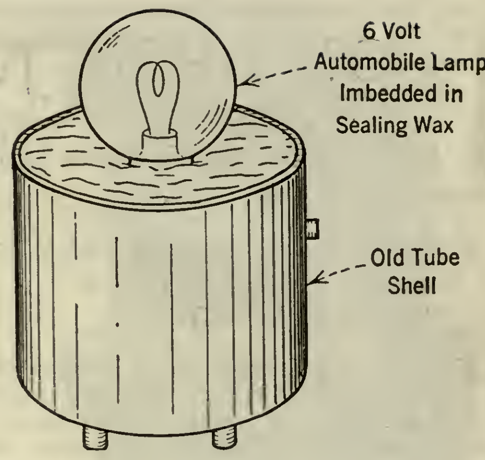


FIG. 3

and if it doesn't burn out in any of them, it is safe to put all tubes in their sockets, and go ahead with other testing. If, however, the plate battery *has* been wrongly connected, the cost of the test is a new tube, $2.50, or thereabouts.

Take an automobile lamp socket, either single or double contact, as preferred, and solder two leads to it, connecting this lamp in an old tube base with its two leads connected to the regular filament terminals of the base. Fill around the socket, in the base, with sealing wax. Thus, using one of the small automobile lamps, as in Fig. 3, the cost of the test, in case of a wrong connection, will be reduced to the cost of the small automobile lamp, about 30 cents. This will no doubt appeal to set builders who have had to replace the "test tube," as I have had to do.

W. H. Mayfield, Miami, Arizona.

A METHOD OF SCRAPING WIRE

A KINK that I have never seen in publications, and therefore may be of use to this department, is a method of removing insulation (either cotton or silk) from magnet wire. Until recently, when I had this to do, the only tool that occurred to me was a knife. One day when I had a couple of feet of wire from which to remove the insulation, I had no knife handy, but seeing a piece of emery cloth lying on the bench, I folded it and drew the wire through it a couple of times, and since then have never used a knife for this work. Try it.

W. H. Mayfield,
Miami, Arizona.

Whether you smile or cuss depends upon the service behind your Radio~

What is this radio service which we claim is so necessary?

Do you drive a car?

Do you ever have little things go wrong with it?

You have become so used to minor troubles that you don't condemn the car on which they occasionally occur.

No—

You go right to a service man—a man who knows your make of car. You don't go to a handy man who claims he can fix any car.

That's automobile service, and is one of the main reasons for the auto being the success it is today.

The same service condition exists in radio—the only difference being that people don't yet understand it.

The radio instrument which never requires service has never been built—it never will be.

Like automobile manufacturers, the better radio manufacturers do all within their power to make their instruments mechanically perfect. Nevertheless, like the auto, little things will sometimes go wrong—they are serious to the radio owner but very simple to a factory trained service man.

The handy man who can fix any radio simply experiments until he locates the trouble—such a method was disastrous to the auto in former days—disastrous and expensive in radio today. It is not sound.

Ozarka instruments are sold only by Ozarka factory representatives, men who are factory trained in sales and service, men who sell no other radios but Ozarka.

These men don't pretend to know all about radio but they do know all there is to know about Ozarka—isn't that the kind of radio service you want?

Ozarka instruments are sold under a very definite plan. An Ozarka representative will gladly set up an Ozarka in your home—he won't tune it—he won't tell you what it will do—you must operate yourself. If the results you receive by your own operating won't convince you that the Ozarka gives you the distance, volume, selectivity, tone and ease of tuning that you demand then don't buy it.

Ozarka instruments are built to sell themselves but no Ozarka is sold without factory-trained service behind it.

Openings for a Few More Ozarka Factory Representatives

OZARKA Incorporated, is now entering its 4th year. From a beginning with one engineer, one stenographer, one salesman—our present president, the Ozarka organization has grown to over 3,100 people. There must be some good reason for this growth.

Ozarka instruments have made good—they have more than met competition. Ozarka representatives have made good not only because Ozarka instruments were right, but because they have been willing to learn what Ozarka engineers were willing and capable to teach them—Ozarka unusual salesmanship and Ozarka service.

Send for FREE Book

Radio offers a wonderful opportunity to men who are willing to start at the bottom and build. You need not know salesmanship, but will you learn what we will gladly teach you? You may not know radio, but we can and will teach you if you will do your part. With such knowledge and willingness to work, it doesn't seem possible that you cannot make good. Sign the coupon below, don't fail to give the name of your county. Better still write a letter, tell us about yourself and attach the coupon. If interested in our salesman's plan ask for "Ozarka Plan No. 100."

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122 Austin Avenue B
Chicago, Illinois

Gentlemen: Without obligation send book "Ozarka Instruments No. 200" and name of Ozarka representative.

Name. ....

Address.......................City..................

County.......................State..................

YOU'LL KNOW THE MAN BY THIS BUTTON!

122 Austin Avenue, B
Chicago, Illinois

Gentlemen: I am greatly interested in the FREE BOOK "The Ozarka Plan" whereby I can sell your instruments.

Name..

Address.......................City..................

County.......................State..................

QUERIES ANSWERED

What care does a receiver ordinarily require?

R. J. L. Lincoln, Nebraska.

How may the Beers charger be used to charge storage B batteries?

T. C. N.—Hempstead, New York.

When I add resistance-coupled amplification to the Roberts set the volume is less than originally on two tubes. Why?

M. L. C.—Zion City, Illinois.

How may regeneration be added to my neutrodyne?

T. C. R.—Butte, Montana.

How are the W. E. transformers used in the Roberts circuit?

I. K.—Brooklyn, New York.

Will you publish a table of screw sizes, drill gauges and tap sizes?

C. B.—Philadelphia, Pennsylvania.

RECEIVER RENOVATION

A RECEIVER, like any other piece of intricate machinery, needs frequent overhauling and renovation. It is just as unfair to assume that a motor will function without oil as it is to assume that a receiver will operate satisfactorily without frequent cleanings.

Look over your condensers. If they have a pigtail connection so much the better for them. If they have not, then it should be observed whether a thin film of grease produced by moisture and dust has got into the bearings. Never use oil to lubricate a hard-turning condenser. Rather, try to loosen up on the pivots—or get a new condenser.

If your condenser is composed of a section of stator plates which are cut out of, or assembled into, a solid block, it is absolutely essential that every so often the spaces between the plates be cleared of collected dust. A pipe-cleaner is well suited for this work, and it is not a bad stunt to clean all condensers irrespective of their peculiar assembly.

How are your coil units? Is the wire merely wound on the bakelite or cardboard tubing without any binder? If so, and the coil is loosening owing to shrinkage and drying, put the wires back into place, tighten the turns and then, at the start and finish of the coil, put a dab of collodion, shellac or varnish—this to keep the winding permanently in place. Do not coat the whole coil with this binder as the resistance will materially increase affecting the overall efficiency of the receiver in which it is employed.

Take a look at your sockets. Have the binding posts on them become loose? If so, you can credit them with causing some of the scratchy noises which you have undoubtedly heard. Also look at the contact blades of the sockets and see that they have not been bent down so far that there is no contact between them and the tube prongs. Brighten the surface of the tube prongs and be sure none are loose.

If, in the construction of your receiver, there has accumulated between the battery terminals, or any other contacts in the receiver, a deposit of soldering paste, remove it with a washing of alcohol.

Don't let your batteries get dusty, especially between the terminals, and be sure to coat the terminals of your A battery with vaseline to prevent corrosion. Phone and loud-speaker cords often become wet or if they have come in contact with the top of the A battery the insulated cotton covering becomes rotted and soon a short circuit between the tinsel wires occurs.

CHARGING A AND B BATTERIES

THE Beers universal battery charger described in the September Radio Broadcast may, with the addition of a lamp and a few wires, be made to conform with its name and be employed as both A and B battery charger.

No change in the original circuit is necessary and it was found by experiment that both A and B batteries could be charged simultaneously. Of course, when a 6-volt battery is charged at the same time as a B battery, the amount of current passed into the B battery is lower than when only the latter battery is on charge. The output charging rate of 2 amperes will be divided proportionally between the two batteries.

With a 200-watt bulb it was found that a charging rate of .7 amperes was obtained on a 48-volt B battery, and with a 50-watt lamp, .18 amperes.

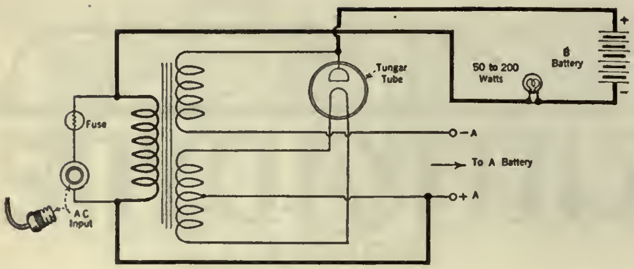


FIG. 1

coupler. If by any chance these connections are so reversed that the plate lead of the first tube connects to the end of the resistance not common to the isolating condenser, then a circuit such as in Fig. 3 will result.

Here, a B-battery potential will be applied to that end of the plate resistance connected to the isolating condenser and the effective voltage drop across the plate resistance will not be realized.

Those who employ resistance-coupled amplification in their receivers are cautioned to check over the connections to this part of the amplifier as satisfactory operation of the receiver is entirely dependent upon the correct hookup of the plate resistance. In Fig. 4 the incorrect circuit is shown in another form and as it would be recognized in a receiver.

With the A battery on charge at the same time, the current in the B battery circuit was cut to about one third its former value.

To charge B batteries it is only necessary to connect the positive terminal of the battery to the graphite electrode of the tungar tube, i.e., the lead coming out of the top of the tube.

The negative side of the battery connects to one side of the a. c. line. The other side of the a. c line connects to the positive output terminal of the A battery charger. In the circuit diagram Fig. 1, the heavy lines indicate the new connections for B battery charging. It is obvious that by varying the size of the lamp in the charging circuit, within the limits specified, the charging rate may accordingly be varied.

The above specifications hold good only for a 48-volt B battery. Do not try by this method to charge a 96-volt or larger bank of B batteries.

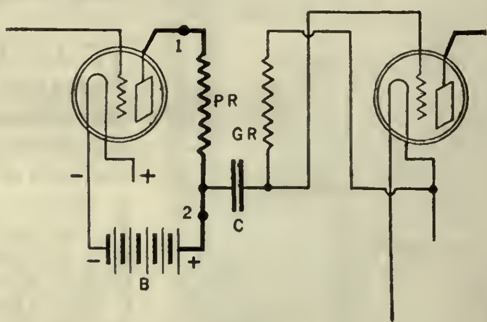


FIG. 3

RESISTANCE COUPLING IN THE ROBERTS KNOCKOUT

MANY constructors have endeavored to add resistance-coupled amplification to their two-tube Roberts receivers with varying results. Some were successful, others not. If the circuit is observed and analyzed, it will be noted that the input connections to the first resistance coupler are not like that of a transformer-coupled amplifier. The detector-plate resistance, having B-battery current flowing through it, is isolated from the grid of the next tube by an isolating or blocking condenser. These points are brought out in Fig. 2.

Now supposing a pair of leads are brought from the output of a tube, such as at 1-2 Fig. 2, and are connected to the plate resistance of the resistance

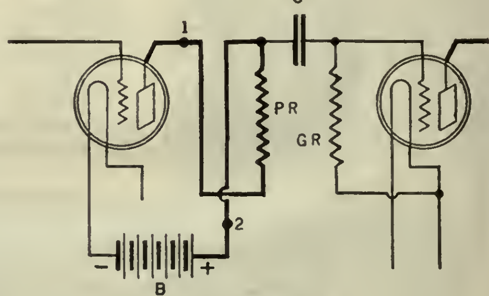


FIG. 4

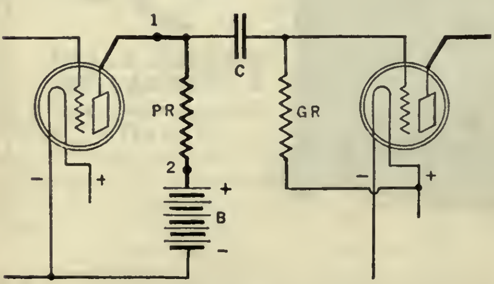
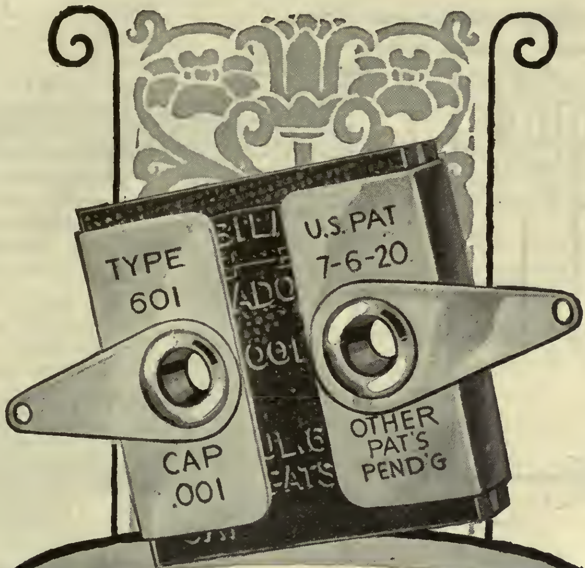


FIG. 2

While on the subject of resistance amplification, it is well to state that the output amplification of the unit may be unquestionably increased with the use of the new high-mu tubes especially designed for use in resistance-coupled amplifiers.

ADDING REGENERATION TO THE NEUTRODYNE

IT HAS generally been assumed that the addition of regeneration to a receiver was theoretically equal to the addition of a stage of radio-frequency amplification. Furthermore, in the use



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standard fixed radio condensers

NEARLY all of the leading manufacturers of radio sets have adopted the Micadon as their standard.

A layman might be fooled—not so these manufacturers. They need fixed condensers with *accurately matched* and permanent capacities, and they know which are the best. Year after year, they buy millions of Micadons. This overwhelming preference is your assurance of *quality*.

Send 10 cents for 32-page booklet "applications of Dubilier Condensers in Radio Circuits." Address Dept. H-2. 4377 Bronx Boulevard, New York City

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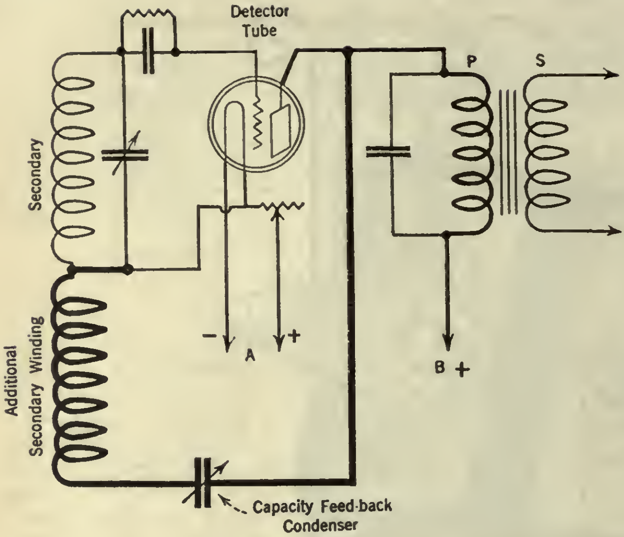


FIG. 5

of regeneration, it is possible to tune a receiver by the squeal method which is admitted to be practically the easiest system in use. In the standard neutrodyne, unless the receiver be improperly neutralized, it is not possible to realize the benefits from such a system of tuning, and often a station is passed by simply because the peculiar whistle is not present.

To include regeneration in a receiver of this type, it is possible to choose from two systems—namely capacity feedback or inductive feedback, otherwise recognized as "tickler regeneration." The former has the advantage over the latter system in that the adjustment of regeneration is independent of wavelength and does not affect the tuning properties of the receiver.

In tickler control a readjustment usually throws out the main tuning control a trifle. Inductive feedback is, however, the more common form in use to-day and usually consists of a coil of wire located in the plate circuit of the detector tube. It is coupled to the detector secondary. Another method of doing the same thing is to employ a variometer in the plate circuit of the detector.

The capacity-feedback system has only lately come into extensive use and is the one described here.

The usual secondary coil in a neutrodyne consists of about 60 turns of wire wound on a cylindrical form. To this coil, at the filament end, must be added from one third to one half the number of turns already on the secondary. Then at the new lower end of the entire coil is connected one terminal of a variable condenser the other contact of which connects to the plate of the detector tube. The circuit is shown in Fig. 5. The heavy lines indicate that part of the circuit which is new, comprising the capacity-feedback system.

For individual receivers it may be necessary to experiment with additional coils having various turn-values. Also the experimenter will find that with some coils a small condenser is satisfactory where in other cases only a larger condenser will do.

The most satisfactory and successful arrangement is that where, with a given number of turns, regeneration over the whole wavelength range of the receiver will be obtained over the whole scale of the capacity-feedback condenser dial.

The experimenter may wind the additional coil in any way convenient, according to the mechanical and physical limitations of the particular part of the receiver where the coil is to be placed. It may be bank wound, random, or in any of the concentrated forms such as basket weave, diamond weave, or spider-web. The latter offers greatest possibilities because of the space saved in its use. One important thing to remember is to wind the new coil in the same direction as the original secondary.

WESTERN ELECTRIC PUSH-PULL TRANSFORMERS

SINCE the publication, in the July "Now I Have Found Department," of the article by Mr. H. Q. Horneij, describing the construction of a four-tube Roberts receiver employing a brace of Western Electric power-amplifier transformers, we have been asked where the transformers might be purchased and why, from a "new idea" standpoint, the article appeared in the above-mentioned department.

To answer the last question first, the article was presented to our readers because the use of Western Electric transformers guaranteed nigh on to perfect loud-speaker reproduction of voice and music.

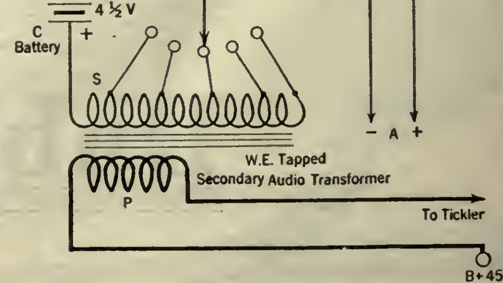


FIG. 6

ECONOMY

NO ONE size or type of battery can be economical on every type of receiving set. That's why Eveready Radio Batteries are made in different sizes and types —so that every radio user can enjoy the economy that is to be had by fitting exactly the right Eveready Battery to his receiver. For owners of sets with five, six, eight or more tubes, and power amplifiers, there is the extra-large, powerful and unusually long-lasting Eveready "B" Battery No. 770. There is an Eveready dealer nearby.

Manufactured and guaranteed by

NATIONAL CARBON CO., INC.

New York San Francisco

Canadian National Carbon Co., Limited
Toronto, Ontario

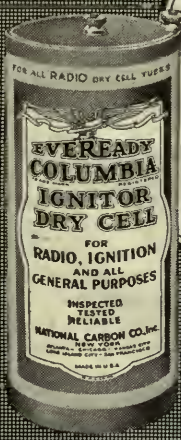
★

EVEREADY
Radio Batteries
–they last longer

EVEREADY HOUR
EVERY TUESDAY AT 9 P. M.
Eastern Standard Time

For real radio enjoyment, tune in the "Eveready Group." Broadcast through stations—

WEAF	New York	WCAE	Pittsburgh
WJAR	Providence	WSAI	Cincinnati
WEEI	Boston	WWJ	Detroit
WFI	Philadelphia	WCCO	Minneapolis / St. Paul
WGR	Buffalo		
WOC	Davenport	WCTS	Worcester



Eveready Columbia Ignitor "A" Battery, the proven dry cell for all radio dry cell tubes 1½ volts

No. 766 22½-volt Large Horizontal Price $2.00

No. 770 45-volt Extra-Large Vertical Price $4.75

Many owners of receivers already had in their possession the old Western Electric power amplifier and here was a good chance to incorporate it in a receiver of the highest type.

The tapped secondary of the first stage presented an opportunity to use this transformer for the control of volume in the Roberts receiver, when used in the audio-reflex stage. This application is embodied in the circuit diagram Fig. 6.

Naturally, the use of the W. E.-216-A tubes is essential to undistorted output inasmuch as the use of UV201A tubes with the Western Electric transformers would be a poor combination resulting somewhat in a loss in volume and clarity of output.

SCREW THREADS COMMONLY USED IN RADIO

THE fan who makes his own must often rely upon the data contained in radio publications for the correct sizes of drills, taps and screws, to use in the assembly and general construction of his receiver and other radio apparatus.

Many can boast of a steel tap and drill gauge in their collection of tools, and with this handy adjunct to the constructor's shop, it is possible at a glance to know the proper size drill to be used by merely inserting the screw to be used in the hole in the gauge in which it properly fits.

However, not all have these gauges and so in Fig. 7 is shown a table which lists the screws and threads most commonly used in radio apparatus construction, with the corresponding clearance drill hole sizes and tap drill sizes.

The column on the left lists the screw sizes. The center column shows the tap drill sizes which naturally are smaller than the clearance holes, which are listed in the last column.

SIZE OF SCREW	TAP DRILL SIZE	CLEARANCE DRILL SIZE
2-56	48	42
3-48	44	37
4-36	41	31
5-40	36	29
6-32	33	27
7-32	30	22
8-32	28	18
9-32	24	13
10-32	20	9
10-24	23	9
11-24	19	3
12-24	15	1
14-24	6	¼
14-20	10	¼

FIG. 7

If it is desired to tap a piece of brass or bakelite for a 6-32 machine screw then a No. 33 drill is used.

If the screw is to be used to clamp two pieces together, then a clearance hole is drilled to allow the screw to pass through and into the hole with ease. In this instance a No. 27 would be used for the drilling.

Where a hole to be threaded does not go through the material but only is drilled for part of the way, then a tap having a blunt end with a uniform diameter is more satisfactory because if a tapered tap were used the threading would not be complete at the bottom of the hole. Where the hole does go through, then a tapered drill may be employed.

In all tapping operations, only work the tap for two or three threads, working it back and forth and then remove it so that chips or dust may be taken out. Repeat the operation which will insure a clean thread.

When writing to the Grid, please use the blank printed below.

GRID INQUIRY BLANK

Editor, The Grid,
RADIO BROADCAST,
Garden City, New York.

Dear Sir:

Attached please find a sheet containing questions upon which kindly give me fullest possible information. I enclose a stamped return envelope.

(Check the proper square)

☐ *I am a subscriber to* RADIO BROADCAST. *Information is to be supplied to me free of charge.*

☐ *I am not a subscriber. I enclose $1 to cover costs of a letter answering my questions.*

My name is ________________________________

My address is ________________________________

G. O.

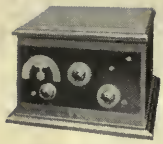
INDEX

(* Illustrated Articles. Editorials in Italics)

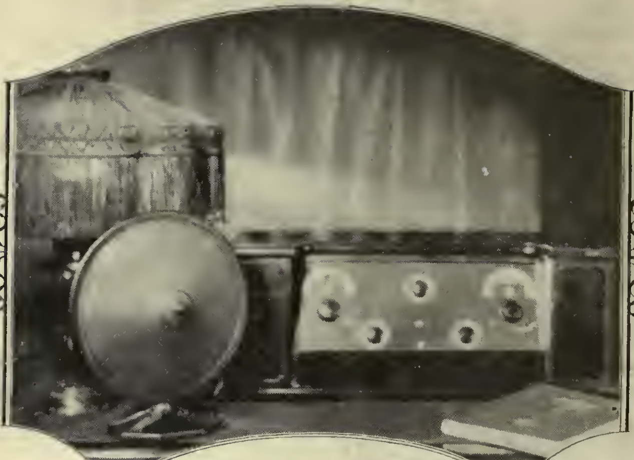
PORTRAITS

(*Portraits in "The March of Radio")

AUTHORS



Crosley
2 Tube 51 S. D.
Mahogany finished cabinet holds all batteries $23.50



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Musicone De Luxe... $27.50
Super-Trirdyn Special 60.00
Console Table.......... 25.00
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A genuine long range receiving set......$9.75

Crosley
3 Tube 52 S.D.
Highly selective; unusual range mahogany finished cabinet. $32.50

Better Results from 3 Tubes than from 5

Instead of passing the incoming signal once through each of 5 tubes, Crosley design, in the Super-Trirdyn, passes it through two of the three tubes several times, each time building up its strength and adding to its volume.

Even the technically uninitiated can see the advantages: simplicity instead of complexity; fewer dials to adjust; sharper accuracy in selecting stations; greater clarity; greater volume, greater ease in logging stations.

This simplicity of design combined with the economies of gigantic production makes possible a price of $60.00 on the Super-Trirdyn Special, the most efficient and beautiful of all Crosley receiving sets. For Crosley is the world's largest builder of radio sets—owning and operating parts factories, cabinet woodworking and assembly plants.

Listen to a Crosley Super-Trirdyn under the most exacting conditions and you will understand why it represents a genuine achievement in radio performance and value which all America was quick to recognize and reward with increasing sales.

Write for an illustrated catalogue of the complete Crosley line or see them at your Crosley dealer's. Authorized sales and service stations everywhere.

Crosley manufactures receiving sets which are licensed under Armstrong U. S. patent No. 1,113,149 and priced from $9.75 to $60.00 without accessories. Add 10% to all prices West of Rocky Mountains. Crosley owns and operates WLW first remote control super-power broadcasting station.

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